October 2023

Our long-term delivery strategy

2025 – 2050

Affinity Water

Content

Our Ambition

Introduction

Our long-term delivery strategy (LTDS) has helped to shape our PR24 business plan for 2025 to 2030; it outlines the public value we provide through our services. Our ambitions support the challenges we face, such as population and economic growth in our region, whilst helping to take care of the environment, especially the globally rare chalk streams unique to our supply area region. Being transparent and open and prioritising customer engagement has never been so crucial to building industry trust, we have therefore set these at the heart of our approach to developing this strategy.

The next 25 years will require significant investment to meet the challenges ahead of us and it has never been more important to reflect the views of current and future bill payers to achieve fairness between generations. In reflecting these priorities, our LTDS will deliver significant improvements in performance, providing a better service for all our customers.

Collaboration across sectors is essential to help realise our ambitions. Through partnering with other organisations, we can create cost-effective solutions collectively, in areas such as catchment protection, climate change, customer behaviour, and accessing new water sources. We have sought out collaboration opportunities wherever this may improve the value we can deliver.

In this chapter, we present our strategic vision and what this means for our current and future customers. We outline our seven integrated investment strategies and explain how they align and their role in mitigating future challenges and achieving our ambitions.

Figure 1: Our ambition statements

Our vision

Our vision is to be the UK's leading community-focused water company.

In early 2021, we collaborated with customers and stakeholders to shape and test our ambitions[1]. As part of this research, we conducted a survey of 1,200 customers and the research validated our ambitions, with environmental protection highlighted as a top priority. We published our updated Strategic Direction Statement (SDS) in 2022 and this outlines our four ambition statements guiding our strategy until 2050.

Our LTDS explains how our seven investment strategies align with our vision and outlines their benefits with a focus on our core pathway. It is an integrated plan, therefore these strategies work both individually and collectively in terms of their impact on customer bills. We have assessed

[1] https://www.arup.com/perspectives/publications/corporate-reports/section/annual-report-2019

their value using the six capital benefits. This approach factors in the non-financial impacts and dependencies such as natural, financial, social, intellectual, manufactured and human benefits. See Figure 2. For more details on this approach see Appendix AFW08 of our PR24 business plan.

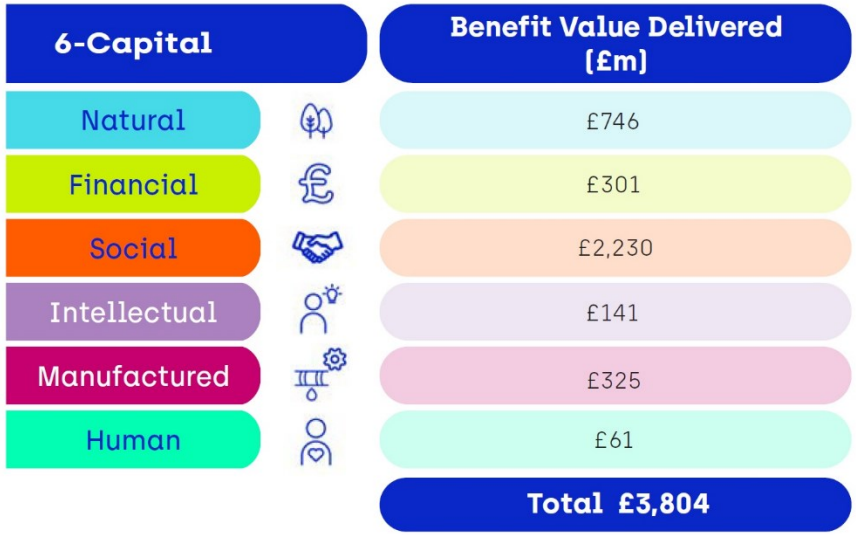


Figure 2: Six capital benefits of our LTDS

Our investment strategies

Our environmental ambition is to leave the environment in a sustainable and measurably improved state.
Two of our LTDS investment strategies contribute to our environmental ambition. These are the Water Industry National Environment Programme (WINEP) and Net Zero strategy.

The WINEP. is vital for ending unsustainable groundwater abstraction, achieving net gain in Natural Capital, and improving watercourse ecology. It aligns with our Water Resource Management Plan (WRMP) to replace unsustainable aquifer use with surface water sources.

Net Zero. is central to our ambition to achieve Net Zero carbon by 2045 – five years ahead of the government's 2050 target. It ensures substantial emission cuts through standard enhancements and operational Net Zero by 2030.

Our ambition for our customers is to deliver what our customers need, ensuring affordability for all.
Most of our customer ambitions will be delivered through base costs which are crucial for daily operations. Whilst our LTDS places affordability, and maintaining high quality water as a key focus, we have produced a strategy which specifically outlines our approach to dealing with lead pipes and we aim to surpass expectations by pioneering a 'lead-free society.'

Lead. From 2025 to 2030 onwards, we will test new ways to reduce lead exposure, aligned with the priorities set out by the Department for Environment, Food and Rural Affairs (Defra). By 2050, we will remove lead pipes in 11 high risk zones and replace pipes with lead above 5µg/l and in any property where the customer has replaced their own lead pipes. We will partner with the government to conduct trials and long-term planning.

Our ambition for resilience – be prepared for change, and resilient to shocks and stresses.
Most of our resilience goals are met through base costs, to ensure we undertake wise investment for long-term resilient services. Four of our LTDS investment strategies contribute to our resilience. These are:

Our WRMP. This sets out our plans to provide a reliable, resilient, efficient, and affordable water supply to our customers between 2025 and 2075. It highlights the challenges we face and how we intend to maintain the balance between water supply and demand, while protecting our environment. It is based on a shared, regional approach; we share our significant and complex water resources challenges with five other water companies as part of an alliance called Water Resources South-East (WRSE) and our WRMP is based on WRSE's first ever regional plan. Our WRMP includes new water resource options, an increased smart metering programme, further reductions in leakage and an ambitious 110 litres per head per day (l/h/d) water use in a dry year target, which will require significant societal change, supported by government legislation and policy.

Raw water deterioration. Through a nature-based approach integrated with the WINEP, we will manage raw water quality to maintain our industry-leading drinking water quality performance and reduce the risk of interruptions to supply.

Resilient assets & systems. This strategy will ensure our assets remain resilient in the face of external risks such as climate change, and that they can operate as resilient systems by addressing significant single points of failure. This includes strategies that encompass addressing climate change impact on our water network, single points of failure, and flooding resilience.

Security & Emergency Measures Direction (SEMD). This strategy ensures customers always have access to alternative water during incidents and emergencies, mitigating vulnerabilities on our sites and enhancing both physical and cyber security measures.

Our ambition for our communities – work with our communities to create value for the local economy and society.
The core focus in our LTDS is to build trust and deliver public value. Collaborative dialogues with communities shape our ambitions and their pathways, and strong community partnerships aid solution funding and delivery, such as our catchment improvements. To enhance trust, we will boost transparency, sharing our performance and challenges and we will openly publish our key uncertainty monitoring plan from 2025.

Our investments follow a 'Green Book' approach,[2] prioritising community value across the six capital benefits. Our Independent Customer Challenge Group (ICG), external technical assurance and our Board ensure robustness and engagement in this approach.

Improving our catchments in our communities

Working in partnership with local stakeholders, community groups, businesses and catchment partners is core to how we deliver environmental improvements in our catchments and generate wider investment in ecosystem services. Through our catchment and river restoration schemes, we deliver multiple benefits to water quality, water quantity, carbon, and biodiversity through creating new habitats, tackling Invasive Non-native Species (INNS), and managing land more sustainably. In the River Beane chalk stream catchment in Hertfordshire, we work with local farmers to implement measures such as cover crops and companion crops to reduce pollution, protecting the river and groundwater. We have also partnered with the Environment Agency (EA), local river groups and the Wildlife Trust to complete a series of river improvement projects and tackle INNS. Between 2025 and 2030, we are expanding this to an ambitious flagship chalk stream catchment restoration scheme which will shape our future work on chalk streams.

What our ambition will mean for our customers

To ensure our LTDS meets the expectations of customers and stakeholders, we started from a detailed understanding of our current performance and our customers' priorities and forecasted the performance required to meet those priorities alongside our obligations. Our long-term ambitions for our customers can be seen in Figure 3 below.

[2] https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent/the-green-book-2020

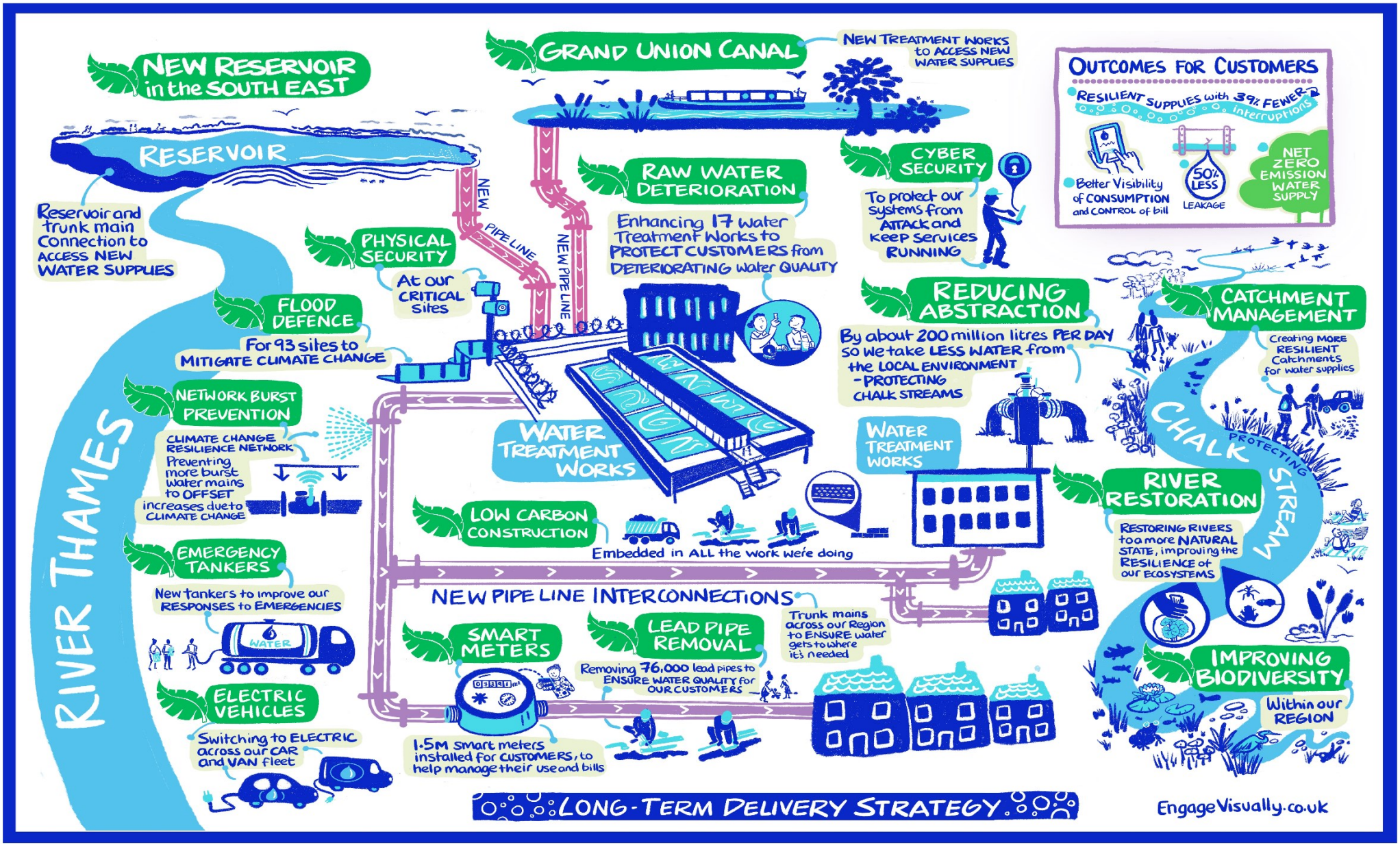


Figure 3: What our ambition will mean for our customers

Our strengths and our performance
Our strong current performance provides us with key areas of strength to build upon across several of the most important measures of service for our customers (see Table 1).

Key areas of strength
Compliance Risk Index (CRI). Since 2020, we have maintained our upper quartile performance and we will continue improvements in this area through base expenditure to ensure customers continue to receive high quality water.

Leakage. We are on track for a 20% reduction in leakage, achieving a significant reduction in 2022-23. Driving down leakage remains a top customer priority, planned through base expenditure for a decade, with enhancements as leakage drops further.

Interruptions to supply. Although the extreme weather in 2022/23 impacted our score, we do have strong underlying performance in this area. We will continue to invest base expenditure to make us more resilient to extreme weather shocks, which are becoming more frequent with climate change.

Key areas to improve upon
C-Mex. We want to be one of the leading water companies for customer service. We know there is much to do, and we will prioritise customer communication and reliability. We will continue to invest significantly through the retail price control to improve our customer experience and handling of complaints, tailoring experiences to the specific needs of those within our communities.

Per Capita Consumption (PCC). Lowering consumption has proven a significant challenge, particularly considering the impact of the Covid-19 pandemic on our performance. We will use insights from our 'Save Our Streams' campaign and 'WaterSave' tariff trial to swiftly improve in this area. The rollout of smart metering will also help to enable real-time tailored communication and better engagement.

		2020-21			2021-22			2022-23		
2022-23 quartile position		**UQ**	**MQ**	**LQ**	**UQ**	**MQ**	**LQ**	**UQ**	**MQ**	**LQ**
CRI										
Leakage Reduction %										
PCC Reduction %										
Interruptions to Supply										
Mains Repairs per 1000km										
Unplanned Outage										
C-MeX Score										
D-MeX Score										

Table 1: Industry comparative performance

Performance levels for our customers
We set ambitious performance goals, rooted in customer preferences and public value principles. These targets, aligned with Ofwat guidance, stem from informed base expenditure and LTDS focus on maximum customer benefit.

Figure 4: Creation of targets for Performance Commitment process

Our process connects our enhancement schemes, base Capex, and Opex to performance benefits. We reviewed contributing activities with internal stakeholders and ensured external assurance for all commitments.

Ambition	PC	Unit	PCL	2025 - 2030	2030 - 2035	2035 - 2040	2040 - 2045	2045 - 2050
Environment	Biodiversity	Biodiversity units per 100km² for which the company provides monopoly services	PCL from base	0.00	0.00	0.33	0.68	1.02
			PCL customers receive	2.70	5.40	6.07	6.76	7.43
	Operational greenhouse gas emissions (water)	Tonnes CO_2e per [unit and date range TBC]	PCL from base	58343.55	55174.23	51366.47	50544.99	49938.49
			PCL customers receive	55859.31	52721.69	47106.24	46121.9	45545.73
	Serious pollution incidents	Number	PCL from base	0	0	0	0	0
			PCL customers receive	0	0	0	0	0
	Abstraction incentive mechanism (Bespoke)	Ml/d against baseline	PCL from base	0	0	0	0	0
			PCL customers receive	0	0	0	0	0
Resilience	Leakage	% reduction in Ml/d for a three year average from 2019-20	PCL from base	28.4%	35.1%	38.6%	41.9%	44.1%
			PCL customers receive	31.0%	38.4%	44.5%	48.8%	51.7%
	Per capita consumption (PCC)	% reduction in litres/person/day for a three year average from 2019-20	PCL from base	0.0%	0.0%	3.1%	6.3%	8.4%
			PCL customers receive	16.2%	19.5%	25.8%	32.1%	36.3%
	Business demand	% reduction in Ml/d for a three year average from 2019-20	PCL from base	9.20%	9.20%	6.80%	7.20%	7.30%
			PCL customers receive	11.00%	13.20%	16.10%	16.80%	17.00%
	Mains repairs	Number per 1,000 kilometres of mains	PCL from base	132.6	130.6	129.2	126.8	123.3
			PCL customers receive	132	130	127	124	120
	Unplanned outages	%	PCL from base	2.14%	1.74%	1.50%	1.50%	1.50%
			PCL customers receive	2.14%	1.74%	1.50%	1.50%	1.50%
Customers	Water supply interruptions	Hours:minutes: seconds (HH:MM:SS) per property per year	PCL from base	00:04:11	00:04:11	00:04:09	00:04:04	00:03:58
			PCL customers receive	00:03:40	00:03:30	00:03:20	00:03:10	00:03:00
	Customer contacts about water quality	Customer contacts per 1,000 population	PCL from base	0.67	0.67	0.67	0.67	0.67
			PCL customers receive	0.67	0.67	0.67	0.67	0.67
	Average time customers experience low pressure (Bespoke)	The average time (hours: minutes: seconds) that water pressure is below 15 metres head	PCL from base	01:43:43	01:33:43	01:15:00	01:00:00	00:45:00
			PCL customers receive	01:43:43	01:33:43	01:15:00	01:00:00	00:45:00

Table 2 – Performance levels for our customers

Key outputs of our LTDS core pathway

We developed our investment program using a Green Book approach, integrated for value and affordability. This results in seven interdependent 'investment strategies' for our enhancement schemes. The table below is a summary of key outputs and ambitions aligned with our Strategic Directions Statement (SDS) goal.

Ambition	LTDS Strategy Area	Key Output Metric	Unit	Total by 2050	Performance Commitment Benefits
Environment	WINEP	Reduction in abstraction from sensitive chalk stream catchments	Ml/d	126.76	n/a
		Contribution to Water Framework Directive rivers improved to support good ecological status	No. of rivers	19 [1]	n/a
	Net Zero	CO_2 emissions per annum reduced	tCO_2e per annum	5,195 [2]	Operational GHG Emissions
Resilience	WRMP	Additional water sources available for supply	Ml/d	205.21 (dWRMP24)	n/a
		Interconnections across our zones	Ml/d	682.07 (dWRMP24)	n/a
		AMI Smart water meters installed	No. smart meters (000's)	1,483 (Includes HH and NHH)	Leakage, PCC and Business Demand
	Raw Water Deterioration	Drinking water protected from raw water deterioration with enhanced treatment	Ml/d	57.05	CRI and Customer Contacts about Water Quality
	Resilient Assets & System	Additional pressure management devices installed, offsetting the impact of climate change on our water network	No. of devices	169	Mains Repairs, Water Supply Interruptions and Leakage
	SEMD	Additional 'critical national infrastructure' sites provided enhanced security	No. of sites	2	n/a
Customers	Lead	Lead comm & supply pipes replaced	No. of Comm & Supply Pipes	79,800	n/a

Table 3: Key outputs of our LTDS ([1] number of rivers we deliver river improvement works and nature-based solutions over subsequent AMPs will be agreed with the Environment Agency through the WINEP process based on the outcomes of investigations and actions from the previous AMP. [2] based on an average capital carbon saving across the LTDS period of 3,295 tCO2e and an ongoing annual saving from EVs of 1,900 tCO2e)

Challenges and issues we face and our ambitions

Our LTDS addresses company and sector challenges in the short and long term. We highlight these and how our strategies mitigate them with further detail throughout this document. We have used scenario testing for resilience, accounting for uncertainties by examining plausible extremes and sensitivity analysis.

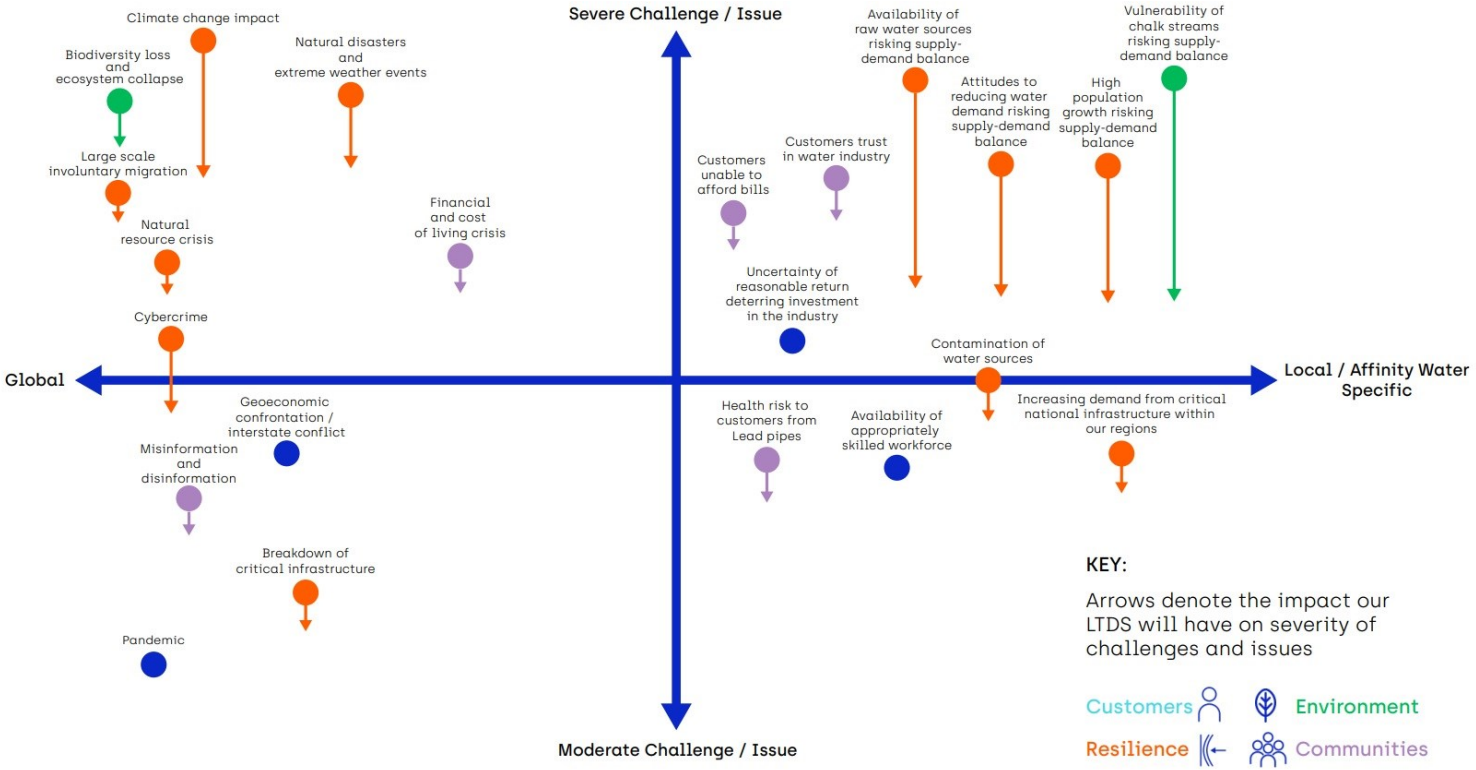


Figure 5: Challenges and issues we face

Summary of our strategy

We have developed our LTDS as an integrated strategy, with the interdependencies between each of our seven investment strategies considered and the overall strategy optimised for best value and affordability. In this section, we summarise the whole strategy, the impact on customer bills and how customer and stakeholder views have shaped it.

Pathways to achieving our ambition

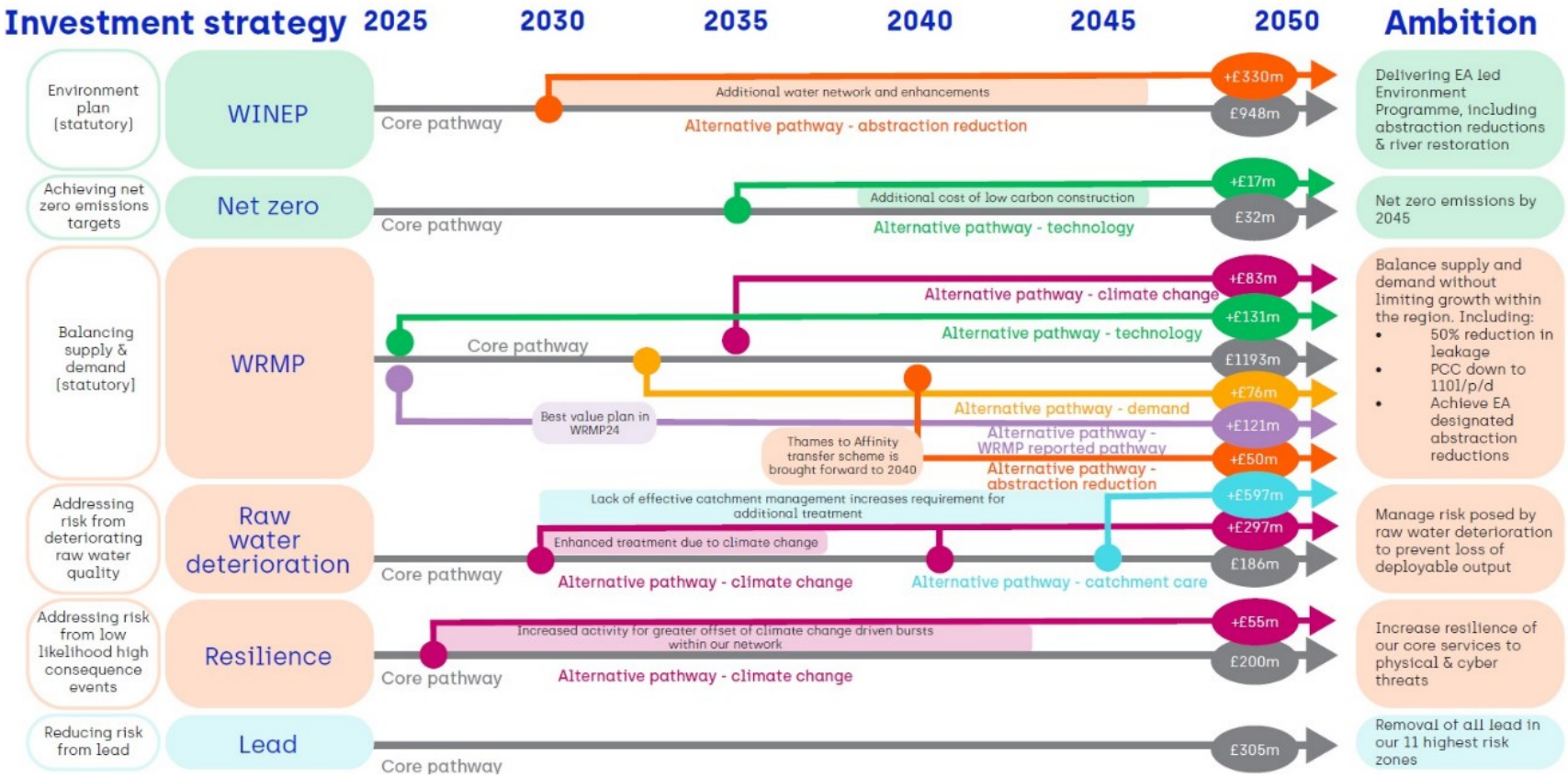


Figure 6: LTDS core and alternative pathway

		2025 – 2030	2030 – 2035	2035 – 2040	2040 – 2045	2045 – 2050
Total Core Pathway	**Bill Profile**	**£21.55**	**£17.79**	**£7.85**	**£7.07**	**£4.64**
	Benefit Profile	**£67.183m**	**£372.648m**	**£406.115m**	**£408.058m**	**£494.116m**
WRMP *(exc. DPC)*	Bill Profile	£10.06	£10.80	£2.12	£1.88	-£0.60
	Benefit Profile	£34.046m	£192.004m	£181.285m	£161.411m	£233.933m
WINEP	Bill Profile	£6.27	£4.80	£3.42	£2.83	£2.51
	Benefit Profile	£14.186m	£48.209m	£67.508m	£81.445m	£90.145m
Resilient assets & systems	Bill Profile	£0.78	£1.26	£0.43	£0.31	£0.26
	Benefit Profile	£11.251	£39.241m	£43.518m	£46.065m	£47.251m
Lead	Bill Profile	£0.11	£0.92	£1.44	£1.85	£2.32
	Benefit Profile	£3.540m	£24.247m	£39.657m	£49.581m	£55.377m
Net Zero	Bill Profile	£0.23	£0.07	£0.02	£0.01	£0.01
	Benefit Profile	£1.554m	£10.639m	£9.734m	£2.806m	£2.217m
SEMD	Bill Profile	£0.66	£0.09	£0.20	£0.17	£0.16
	Benefit Profile	£0.268m	£12.337m	£22.032m	£28.898m	£33.321m
Raw Water Deterioration	Bill Profile	£3.43	-£0.16	£0.22	£0.02	-£0.02
	Benefit Profile	£2.338m	£45.971	£43.381m	£37.852m	£31.870m

Table 4: Bill impact of our core pathway on customers[3]

		2025 – 2030	2030 – 2035	2035 – 2040	2040 – 2045	2045 – 2050
DPC Costs WRMP	Bill Profile	£1.59	£14.72	£8.11	-£3.29	£1.71

Bill impact and customer protections

Our core pathway requires a significant and sustained increase in investment levels, with the inevitable impact of increasing bills over the long-term. Before testing whether the bill impacts of our strategy are acceptable, we considered bill impacts throughout the LTDS development in the following ways:

- Set ambitions based on customer priorities, with explicit support for any investment strategies going beyond statutory requirements, to ensure no superfluous investment, as detailed in our Ambition chapter.
- Phased our investments based upon a best-value approach using NPV calculations and investment optimisation tools.
- Undertook robust adaptive planning to keep investments 'low regret', as detailed in the 'Summary of our rationale' section for each investment area.
- Re-tested support for the ambitions of each investment strategy with customers, providing associated bill impacts to ensure support for investments is informed by an understanding of the bill impacts.
- Set appropriate asset depreciation rates that align the generations of bill payers with those that receive the benefits. We then test that this achieves intergenerational fairness by examining the alignment between bill and benefit profiles, as shown in Table 4.

Our WRMP 'Strategic Regional Options' will be funded through Direct Procurement for Customers, leveraging markets to keep whole life project costs down. These will have an additional impact on the bill that we have included within our bill impact testing. The additional impact of these schemes is shown in Table 5.

[3] Total additional residential bill across 5 years of each Asset Management Period and total benefit received by customers

Table 5: Indicative DPC bill impacts

Table 6 lays out the bill and benefit profiles under adaptive alternative pathways. It provides evidence that fairness for current and future customers is maintained across the full range of scenarios, with alignment of the profile of bill impacts and benefit received.

		2025 – 2030	2030 – 2035	2035 – 2040	2040 – 2045	2045 – 2050
Pathway 1 Climate Change	Bill Profile	£9.62	£14.87	£1.22	£2.56	£2.96
	Benefit Profile	£20.758 m	£113.756 m	£156.747 m	£182.474 m	£249.889 m
Pathway 2 Technology	Bill Profile	£9.57	£9.16	£2.42	£2.19	£0.01
	Benefit Profile	£13.231 m	£189.335 m	£217.457 m	£204.077 m	£267.756 m
Pathway 3 Demand	Bill Profile	£15.29	£33.26	£0.76	£1.23	£0.49
	Benefit Profile	£44.214 m	£84.059 m	£100.584 m	£94.781m	£110.858 m
Pathway 4 Abstraction Reduction	Bill Profile	£12.64	£17.51	£3.95	£2.81	£1.57
	Benefit Profile	£13.002 m	£204.944 m	£222.773 m	£211.272 m	£298.706 m
Pathway 5 Catchment Care	Bill Profile	-	-	-	-	£2.61
	Benefit Profile	£0	£0	£0	£0	£17.101m
Pathway 6 WRMP Reported Pathway	Bill Profile	£28.04	£16.07	£1.40	£0.07	£1.07
	Benefit Profile	£34.002 m	£188.993 m	£191.445 m	£171.198 m	£248.504 m

Table 6: Bill impact of our adaptive alternative pathways

Customer affordability

The bill impact from the scale of the investment required will create an affordability challenge for our customers, particularly given the current economic environment and cost of living crisis. Testing of the core pathway 25-year bill impact indicates that 27% consider this to be completely or somewhat affordable, with 56% stating the impact to be unaffordable. In recognition of the scale of this challenge, we are introducing four layers of support to insulate customers. When combined, these will help to ensure the bill impacts of our LTDS will remain affordable for our customers over the 25-year period.

The first two layers are actions we will take, and the remaining layers are actions we can facilitate for customers, to enable them to take independent action to help with affordability. We believe it is important that we take all the measures we can before asking customers to make any changes. We have summarised the layers below; and further details are provided in Chapter 5 of our PR24 business plan.

Layer 1 – ensuring our bills are the lowest they can be, as a starting point.

We have challenged ourselves to make sure our costs are efficient, and all options have been considered, to avoid or phase investment to minimise more sudden bill impacts. For example, we have reviewed our investment programme and proposed all potential options for Direct Procurement for Customers to maximise; this encompasses all Strategic Resource Options (SROs) as part of our WRMP. We have tested customer views on run-off rates applied to LTDS capital expenditure to inform how we use 'Pay As You Go' and Regulatory Capital Value run-off levers over the 2025 to 2030 period. Responses are shown in Table , with 47% of customers preferring to keep bills low now.

Response	% of customers
Keep bills low now	46.5%
Unsure	33.8%
Increase bills now	19.7%

Table 7 - Customer views on LTDS Capex run-off rates

Layer 2 – changing our tariffs so our customer charges are fair and help those most in need.

We will use tariffs to make sure that customers pay for the water they use, and those charges fairly reflect consumption, while giving customers tools to help them save money. For example, we are currently trialling an innovative 'rising block tariff', 'WaterSave', which allows customers to better control their bills and incentivises very high users to reduce consumption. We expect this to

have a material impact on affordability over the 25-year period, when combined with the actions laid out in Layer 3.

Layer 3 – providing tools for customers to reduce consumption, and hence bills.

These actions include the installation of 1.5 million smart meters that will allow customers to financially budget for consumption and mitigate bill rises, as well as support through digital applications and real-time information for customers. This will be paired with personalised water efficiency consultations and home energy advice to households who identify as struggling with their water bills. We will work with energy partners to provide energy efficiency and fuel poverty advice. We will also increase our customer-side leakage allowance and subsidise any repair costs up to 100% for customers on social tariffs.

Layer 4 – maximising household disposable income to help offset the water bill.

The previous layers have focused on what we and customers can do to reduce water bills. This layer extends that support by considering how household incomes can be supplemented, to help towards, or even completely offset, the water bill. For example, enhance our 'benefits maximisation' offering and move this in-house and/or fund a resource at the Citizens Advice Bureau to carry out this service.

Protections for customers

Our core pathway contains 'no regrets' and 'low regrets' investments that prepare us for a comprehensive range of plausible scenarios. No pathways require any investment for solutions that would only be needed in adverse future scenarios but require expenditure to start during 2025 to 2030. This protects our customers from the risk of paying for investments that do not deliver the intended value.

To prepare for these adverse scenarios without necessitating potentially superfluous investment, we have used modular or adaptive, scalable solutions that can be enlarged to meet the needs of adverse scenarios as they become more certain. These options are more efficient across the range of plausible futures. For example, both our core pathway and Best Value WRMP includes the construction of our Grand Union Canal transfer in the early 2030a as a 'least regrets' solution to manage our medium term risks, but we have incorporated an early tigger in the adaptive plan to check that there are no delivery issues or clear reductions in future supply/demand pressures before we commit to the larger (100Ml/d) GUC scheme in our Development Consent Order planning application. This can be accommodated in the regulatory framework as the scheme construction is intended to be delivered through DPC routes, which defers most expenditure beyond AMP8.

To further protect customers, over 70% of investment in the 2020 to 2025 period is covered by a Price Control Deliverable (PCD) to ensure customers are compensated for late or non-delivery. The remainder investment is either protected through customer Outcome Deliver Incentives (ODIs) or is too small to materially impact customers' bills.

Customer and stakeholder views have informed our LTDS

The insight and testing of our LTDS with customers have been integral to its development. The voice of the customer has been used throughout the process to shape and challenge the LTDS. We have engaged a wide range of customers and stakeholders including future customers to ensure fairness between current and future generations.

The triangulated insight has shaped and informed our ambitions, our investment strategies and our approach to best value, informing each business case and the solution options within them. We have also explored areas such as tariffs, affordability, community support, and wider social benefit to ensure we have built a plan that not only delivers for our customers but supports our

communities in the future. Our 'Customer Engagement' document, Appendix AFW05 to our PR24 business plan, details how customer views have informed our plans and strategies in more detail, with each investment strategy referencing how these findings have been accounted for.

The consultation and testing phases of engagement across our SDS, WRMP, WINEP and LTDS have enabled us to reiterate and refine our proposals with customers and stakeholders to ensure we were setting ourselves the right level of ambition informed by the trade-offs involved and impacts on the bill. We also tested overall acceptability and affordability of the plans, establishing future bill impacts, and stress-testing whether we have the right priorities at a price our customers can afford and the inter-generational fairness of investments.

We have shared our assured findings both across the business and publicly to ensure transparency.[4]

How our customers informed our investment ambition
Beyond our SDS, WRMP and WINEP engagement, we undertook specific LTDS customer engagement to ensure our non-statutory ambitions reflected customer preferences and had explicit customer support. An example of this engagement and how it has informed our plan is set out in the next paragraph.

We engaged with customer groups that were representative demographics, covering a range of ages, socio-economic backgrounds, levels of vulnerability and areas within our supply region to enable a diverse voice to be heard. Given the long-term focus of the research, future customers were included to understand priorities of those likely to become Affinity Water bill payers in the future. Online focus groups were held, alongside interviews for more vulnerable customers, asking them to rank overall priorities and select options in areas where we could go further. A 'build your own bill' exercise then allowed us to understand these preferences when informed by the potential bill impacts of delivering specific improvements or service levels, shown in terms of total additional bill per customer over the 25-year period. Customers indicated priority with 'A' being the lowest ambition level and 'D' being the highest.

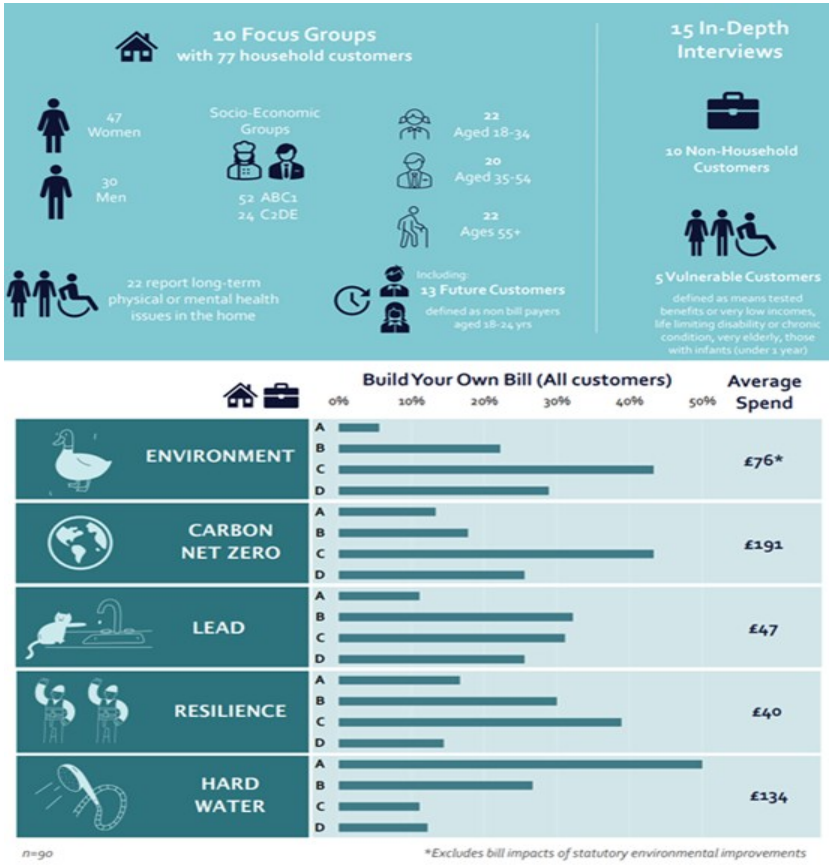


Figure 7: How customers informed our investment ambition, with 'A' being lowest ambition and 'D' being highest

[4] https://affinitywater.uk.engagementhq.com/hearing-from-our-customers

Key findings and shaping our strategy

When examining non-statutory ambition areas in which we could go further, customers supported doing so in areas including Net Zero, the environment, lead, and Resilience, to varying degrees. By contrast, going further in addressing water hardness had very little support. A review of the detailed quantitative and qualitative findings alongside other research led us to amend our draft LTDS in several ways, including:

- We removed our provisional ambitions for addressing water hardness from our LTDS, to be retested at the next 5-year planning cycle.
- We locked in our ambitions to maximise environmental benefits through our WINEP programme and best value approach to all enhancement schemes.
- We locked in our ambition to go faster in achieving Net Zero by 2045 and focused efforts on delivering this more efficiently.
- We calibrated our lead ambition to remove 'lead only' from our 11 high risk zones from one of full lead removal by 2050, reflecting the degree of support
- We calibrated our resilience ambition to address the greatest level of emerging risk and reduce supply interruptions up to a maximum threshold of investment, reflecting the degree of support

How our customers informed targeted performance levels

In addition to testing and reflecting our customer ambitions and overall priorities, we tested specific performance and service levels to ensure the improvement our LTDS delivers reflects customer priorities. We did this through our Water Community[5], which accurately reflects the key demographics of our regions.

Our customers told us which of the service areas they give greatest priority to for additional improvement. We excluded compliance-based measures such as CRI or comparative measures such as C-Mex as these priorities would not meaningfully inform our LTDS. Table sets out the findings of this research, indicating leakage to be the highest priority, with 49% of participants stating this as the most important area for improvement and no participant ranking this as the 8th (lowest) priority.

Priority for improvement	1st	2nd	3rd	4th	5th	6th	7th	8th	Score
Leakage	49% (68)	24% (33)	14% (20)	6% (8)	4% (5)	2% (3)	1% (1)	0% (0)	7
Mains repairs	18% (25)	42% (58)	18% (25)	9% (12)	6% (8)	4% (5)	1% (2)	2% (3)	6.3
Water supply interruptions	6% (8)	8% (11)	20% (27)	22% (30)	18% (25)	12% (16)	9% (12)	7% (9)	4.59
Unplanned outage	4% (5)	7% (9)	12% (17)	16% (22)	20% (28)	18% (25)	14% (20)	9% (12)	4.01
Per capita consumption	11% (15)	7% (10)	7% (10)	10% (14)	17% (24)	15% (21)	20% (28)	12% (16)	3.99
Customer contacts about water quality	4% (6)	5% (7)	8% (11)	12% (16)	14% (19)	18% (25)	17% (23)	22% (31)	3.41
Operational greenhouse gas emissions (water)	7% (10)	4% (5)	9% (13)	15% (21)	6% (8)	11% (15)	20% (27)	28% (39)	3.39
Business demand	1% (1)	4% (5)	11% (15)	11% (15)	15% (21)	20% (28)	20% (27)	19% (26)	3.3

Table 8 - Customer priorities for service improvement

These findings have been accounted for in the following ways through our plan and are reflected in our forecast performance in Table 9.

[5] This is an exclusive online community that hosts a panel of 500 Affinity Water customers with good representation across our geography and segments.

PC	Priority	How these priorities are accounted for within the plan
Leakage	1st	We reflect this high priority through delivering a 50% reduction by 2050 from 2019 levels. This includes a 44.1% reduction from base expenditure and the remainder within **statutory** enhancement investments as part of our WRMP investment strategy.
Mains repairs	2nd	As an asset health metric, performance is primarily driven from base expenditure, where we aim to reduce the frequency of bursts by a further 7% over the period, having made significant progress in recent years. Our LTDS **non-statutory** investments will also deliver a 2% additional benefit as we offset the impact of climate change on increasing burst frequency, as part of our Resilient Assets and Services investment strategy.
Water supply interruptions	3rd	We will deliver continual improvement in supply interruptions over the period from base expenditure. Our LTDS **non-statutory** investments will deliver an additional 58 seconds of improvement through our Resilience Assets and Services investment strategy.
Unplanned outage	4th	As an asset health metric, performance is primarily driven from base expenditure, where we expect to make significant improvements up to 2035, thereon sustaining an industry leading level of performance. Our LTDS **non-statutory** investments in flood defence will prevent climate change deteriorating performance over the period, within our Resilient Assets and Services investment strategy.
Per capita consumption	5th	Whilst a lower priority for customers, the need for performance improvement to balance supply and demand is critical for maintaining customer supplies over the long term. We therefore aim to reduce PCC to 110 litres per person per day by 2050, a 36% reduction from the 2019 baseline. This will be driven through LTDS **statutory** enhancements within our WRMP, including through Smart Metering and behavioural change programmes.
Customer contacts about water quality	6th	As a low priority across our customer engagement, we do not plan to invest further to drive performance improvement, instead investing through base expenditure to maintain our current upper quartile performance throughout the period.
Operational greenhouse gas emissions (water)	7th	Whilst a lower priority for customers compared to other performance, our ambition research clearly indicated an appetite to go further in this area. We have taken a balanced approach by considering these two insights together in how we plan to invest in reducing operational emissions. This includes the majority of improvement coming from base costs, with **non-statutory** LTDS investments in EVs and low carbon construction materials across the first 10 years of the period to accelerate our transition, as part of our Net Zero investment strategy.
Business demand	8th	Whilst a lower priority for customers, the need for performance improvement to balance supply and demand is critical for maintaining customer supplies over the long term. We therefore aim to reduce business demand by 17% across the period. This will be driven through LTDS **statutory** enhancements within our WRMP, including through Smart Metering.

Table 9: How we have accounted for customer priorities for service improvement within our LTDS

Summary of our rationale

The development of our LTDS has been iterative, with increasingly sophisticated understanding at each stage enabling more informed discussions with customers and stakeholders. This in turn informed refinements to our plan and the results of this approach are detailed within each investment strategy.

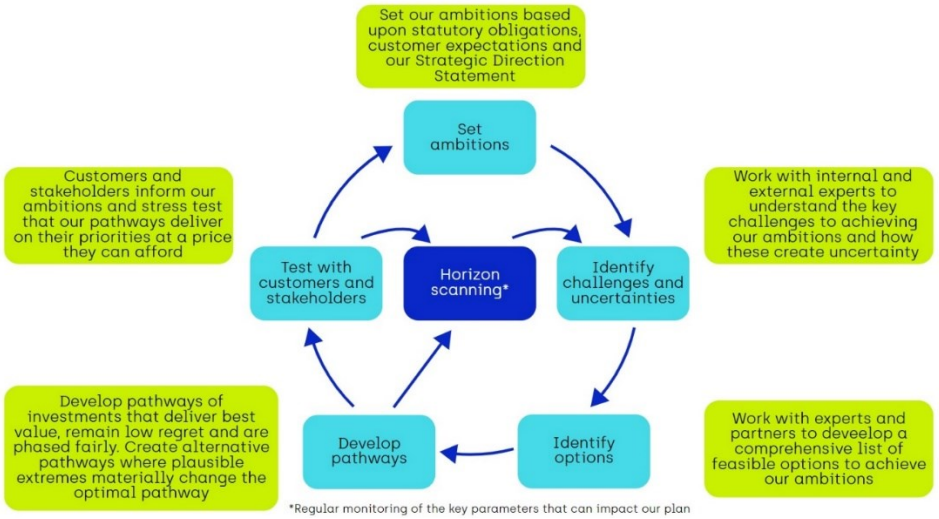


Figure 8: Our iterative LTDS development approach

Identifying challenges and uncertainties

In conjunction with common reference scenario testing, we also considered a broader range of uncertainties. These include those specific to investment strategies, for example, uncertainty in future regulation and legislation, particularly in the case of our lead strategy.

Wider scenarios

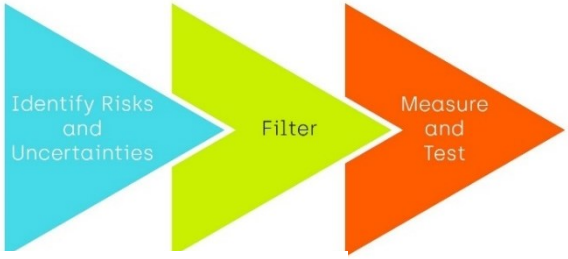


Figure 9: Identifying LTDS Wider Scenarios

Building on the challenges and issues to our ambitions set out in our Ambition chapter, we assessed the uncertainties that these pose to ensure our options and pathways account for the scenarios we face. Through workshops with external advisors, we assessed 20 different challenges or risks to our ambitions, filtering and testing these to inform Common Reference Scenario testing and developed our wider scenario.

Most challenges or risks were found to relate to Common Reference Scenarios or were insufficiently material following sensitivity testing. We concluded with a single wider scenario which we have tested across our strategy alongside the Common Reference Scenarios.

‘Catchment Care’ wider scenario

Our wider scenario is ‘Catchment Care’, addressing the uncertainty of third-party collaboration and partnership to reduce pollutants entering water courses within our catchments which increases risks to raw water quality. Raw water sources in our regions have specific vulnerabilities to contamination, dependent upon land use in our catchments and the effective management of pollution sources such as agricultural and urban run-off, alongside wastewater. For example, in our Central region where we are becoming increasingly reliant on the River Thames and have long-standing reliance on pollution-vulnerable groundwater sources. Our core strategy to manage this risk is to adopt catchment and nature-based solutions first, partnering with land users to minimise risk at the source and minimise the ‘grey’* treatment solutions required and associated base costs e.g., GAC** regeneration. Our strategy includes significant investment in catchment management to protect raw water and our innovative approaches have already proved effective. However, the inherent reliance on the collaboration of external stakeholders represents a material risk to this strategy. Additionally, our catchment management activity cannot influence all potential sources of pollution e.g., those relating to wastewater or historic contamination.

*‘Grey’ denotes a built treatment solution

**Granular Activated Carbon

Identifying options

Having set our ambitions, we identified what could be achieved through base costs, using our 25-year asset strategies to provide stretching but realistic forecasts of performance. Building on these and existing statutory plans, we identified specific needs our LTDS investments must meet across each investment strategy. For example, our lead investment strategy aims to replace 76,000 lead communication and supply pipes by 2050.

From these needs, we identified a comprehensive suite of potential solutions that are likely to be needed under a range of plausible scenarios. In doing so, we consistently considered whether feasible nature-based solutions and partnership working options existed.

Where there was sufficient certainty and specificity in the need, specific schemes were identified and costed, for example, our WRMP included over 200 costed schemes as an input at this stage. Where there was greater uncertainty in the nature of the need, a programme-based approach was taken based on forecast unit costs. For example, we are less certain on specific locations of catchment management activity in the 2040s and are therefore unable to develop detailed costed schemes. Instead, we forecasted the level of need across our catchments, and costed activity based on historic unit costs and assumed efficiencies from technology and innovation.

Developing pathways

We identified a comprehensive set of options and then established the optimal mix and phasing of them We developed our core pathway based on three core principles:

1. Deliver best value to our customers and communities
Our pathways are underpinned by Green Book economic assessments to ensure they deliver best value to customers across the 6-capital benefits discussed earlier in this document.

2. Select a core pathway we will never regret
We have phased all our early investments to ensure they are as ‘low regret’ as possible; representing best value, considering the plausible extreme scenarios we face. These include investments that meet short-term needs or those that will be required to keep options open or remain resilient to an uncertainty, such as our catchment investigation work within our WINEP strategy.

3. Phased investment to ensure pathways are deliverable, affordable, and fair across generations of bill payers

Where we have options on the timing of activity, we have phased investment over the 25-year period to create a deliverable pipeline of activity which ensure affordable bills and does not disproportionately burden any one generation of bill payers. We have discussed the methodologies and findings of scenario testing and the resulting adaptive pathways within our 'Seven investment strategies' chapter, with a summary of the outcomes displayed in Table 10.

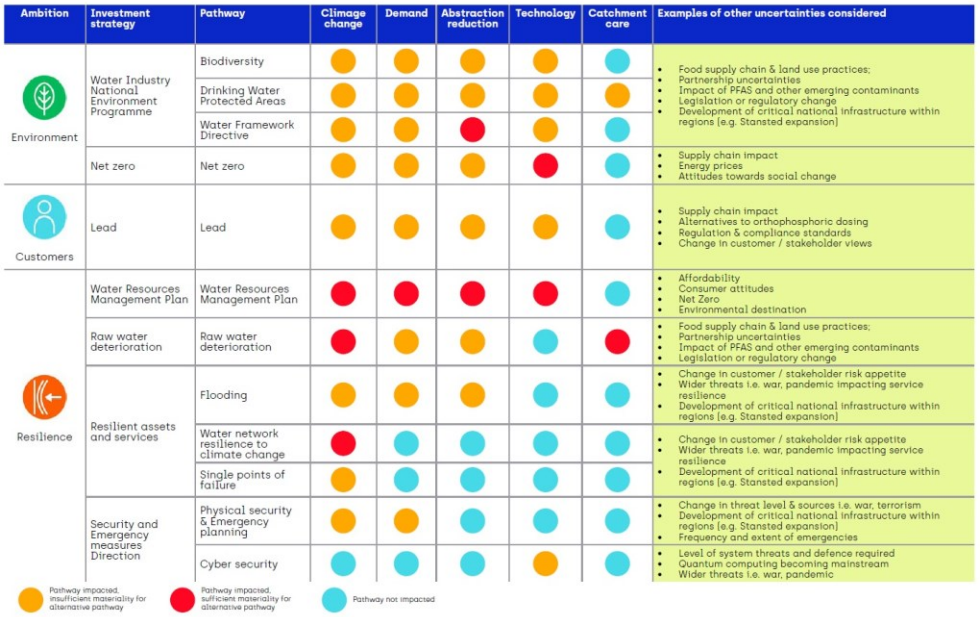


Table 10: Summary of scenario testing results

Horizon scanning

Adaptive planning requires continuous tracking of the implementation of chosen options, and monitoring of future options available, and of key parameters of material uncertainties that influence future options informing the best pathway. Implementation of options in our pathways will be tracked through annual reporting and Price Control Deliverables. Available future options will be reassessed on a five-yearly business planning cycle. Our horizon scanning programme brings these together with monitoring of material uncertainties, enabling revision of our LTDS as a living, reactive document. Material uncertainties will be monitored through specified parameters that track which scenarios we face. As examples, monitored parameters associated with our tested scenarios are shown in Table11.

Scenario	Metrics, source data & frequency	Trigger points (linked to alternative pathways)	Reporting frequency
Climate change	Metric from UKCIP. Source Data from WRSE Regional Climate Modelling	2035	Annual
Technology	Pace of smart metering installation through internal reporting in line with associated PCD	2025/26	Annual
Demand	Population growth measured through number of properties connected to our network and habitants per property. Population forecasting data derived from Edge Analytics. Total demand in Ml/d, calculated as through water balance.	2030	Annual
Abstraction reduction	WINEP investigations outputs & benefits assessments Ongoing groundwater level monitoring, water course flow monitoring and ecological surveys.	2035	5-year review cycle
Catchment care	Nitrate concentrations within the river Thames	Prolonged trend of increase resulting in forecast above current manageable level, leading to final water from WTWs exceeding the regulatory standard	Continual monitoring with annual reporting through our APR

Table 11: Key metrics of horizon scanning

Summary of the foundations of our LTDS

Key assumptions and uncertainties

All long-term planning requires several assumptions about how certain factors will change over time, in order to create and optimise pathways. Scenario testing and resultant adaptive pathways account for most material factors. We have set out the most material factors not explicitly considered within the adaptive pathways, with more detail on the basis and impact of each assumption provided within associated investment strategies in Table 12.

How base expenditure contributes to the delivery of our LTDS

Whilst our LTDS pathways focus on enhancement expenditure, we have built these upon firm foundations of what being ambitious with our base expenditure can buy.

Our 25-year asset strategies use millions of data points across our assets, examining age, condition, and what will be required of them over the long-term to deliver performance. From these, we forecast what the best performance levels we can confidently achieve from base are, and at what cost, when following asset management best practice. At the same time, we also account for the most significant uncertainties, for example, the impact of climate change on the burst rate of our water mains. Within these strategies we reflect the impact of our key enhancement investments from the LTDS pathways, for example, how the shift from groundwater to surface water will impact the deterioration of our water mains. In doing so, we bring together our asset strategies and LTDS as an integrated and optimised plan of investments.

The following sections provide more detail on the specific ambitions being achieved within each investment strategy and the pathways to achieving these with associated rationale and foundations.

Key Assumptions beyond scenario testing	Investment Strategies impacted	Range and materiality of uncertainty
Government and regulatory policy – we have assumed that regulatory requirements will not Significantly change and execution of explicitly policy or government ambitions, for example water efficiency labelling. We detail these assumptions within investment cases where material ranges of plausible uncertainty exist.	**WINEP biodiversity - b**iodiversity Net Gain ongoing 10% requirement for future developments maintained throughout the LTDS period, and that specific biodiversity measures will be required and funded through WINEP, including river restoration. **Lead –** regulatory limit for lead will not reduce below 5µg/l over the LTDS period, which would require significant change in approach. Similarly, changes to any other chemical prescribed concentration value would likely require additional investment. **WINEP WFD** – we have assumed that Environmental Destination requirements and the associated adaptive planning approach under the WRMP will be implemented during the LTDS **Net zero** – changes to the Carbon Budget could increase the depth and rate of decarbonisation required, resulting in a required acceleration of our plan. **WRMP** – we have assumed resilience of supply requirements and targets remain unchanged throughout the LTDS period **WRMP** - We have assumed that there will be approximately 31Ml/d of benefit delivered through government led demand management policies.	A plausible range of variance cannot be established, but if inaccurate this assumption has the potential to fundamentally alter the LTDS and associated costs.
Costs of solutions – we have costed all solutions using the best available data, using actual costs for similar delivered solutions, with third-party verification to ensure these are accurately reflecting efficient costs. Appendix AFW06 of our PR24 business plan provides further detail on how we cost solutions. We have also accounted for technology and efficiency improvements specific to each solution type. We detail these assumptions within investment cases where material ranges of plausible uncertainty exist.	All investments are based on a common framework for developing unit costs. We outline below the key components of this framework. **Future efficiencies –** A frontier shift efficiency of 0.5% has been applied across all enhancement investments from 2025-30, with our rationale outlined in Chapter 7 of our PR24 business plan. We will remain ambitious on the efficiency we can achieve over the remaining 20-years of the period, continuing our strong track record in forecasting and delivering to efficient costs. We will continue to assess the latest indicators of future productivity gains at each price control and reflect these within the costs we present for the following 5-year period. However, there remains a high level of uncertainty of total factor productivity beyond the 5-year horizon, as historic data becomes a less valid indicator for the future over the longer time horizon. To provide our customers with a prudent view of the potential bill impacts of the LTDS, we have not applied a cross-cutting frontier shift efficiency across the portfolio (i.e. 0%). We have, however, applied specific Real Price Effect assumptions where greater certainty exists. We summarise where these most materially impact investment strategy costs below. **Lead** - costs for lead supply pipe and communication pipe replacements have been based on lead programme data from the period between 2015 - 2025. Given the specific focus of this investment within the first 5 years is to reduce unit costs, we have applied a 1.1% per annum adjustment over the proceeding first 15 years of the period, reflecting the significant efficiency gains we expect to achieve here. **SEMD** – costs of cyber security solutions have been forecast to increase by 8.6% between each 5-year period, reflecting a long prevailing increase in the number and sophistication of cyber threats driving up costs above CPIH, a trend that experts do not anticipate will change as technology develops. **WRMP** - all SROs in our WRMP are currently in Gate 3. There is relevant uncertainty about the engineering constraints of certain schemes, which will be alleviated through further development of the options. There could be changes to the associated cost of these options after Gate 3 is completed. (note SRO costs are	A plausible range of 10% variance in relevant capex costs post 2030 could vary pathway costs by £100m within the core pathway and a further £100m within DPC cost.

	expected to largely be incurred through DPC and therefore not included within the LTDS pathways, although still impacting customer bills)	
Customer affordability – we have assumed that changes in socioeconomic factors do not materially change customer affordability or changes to support for non-statutory investments	This assumption applies across our **whole LTDS** and most significantly to the non-statutory areas of investment within **Resilient assets and services** and **lead** investment strategies.	This could reduce support for non-statutory areas of investment from 2030 onwards, the total of which is £400m.
Total number of lead pipes - the assumed total number of lead pipes in the network was generated by taking a baseline of total communication pipes in lead obtained from our Asset Inventory in 2018 and then subtracting the number of lead pipes replaced each year since then.	**Lead** – the number of lead pipes proportionately impacts the cost of removal, assuming constant unit costs. This applies to both the 11 high risk zones targeted within the LTDS and the remaining lead pipes thereafter.	A plausible range of 10% variance could increase or decrease pathway costs by up to £30m across the 25-year period.
Pace of supply chain decarbonisation – we assume that our suppliers can provide low carbon solutions for capital projects at the same pace as the UK needs to decarbonise.	**Net Zero** - this will affect our embedded carbon emissions, and if suppliers are not decarbonising quickly enough, we will need to work with the supply chain to identify innovative low carbon solutions	This could impact both base and enhancement expenditure over the period
Energy grid decarbonisation – we have also assumed that we will no longer require a green tariff from 2035 onwards, as the UK electricity market has decarbonised.	**Net Zero** - if this is not the case, we may have to increase our investment to invest more in renewable energy.	A plausible range of increasing by up to 19m kWh per annum (approx. 10% of total 2035 electricity) increasing costs by £25-30m.
The rate of third-party pollution impacting our raw water supplies – we have assumed one water treatment works per AMP, based on the past incidence of similar events.	**Raw water deterioration** – despite catchment management efforts we anticipate one 'grey solution' of enhanced treatment to be required per period due to third-party pollution.	A plausible range of 50% variance in rate could vary pathway costs by £32m.
Security threat level to the UK remains constant throughout the LTDS period.	**SEMD –** our investments are targeted to meet the requirements of the current threat level. We will continue to monitor intelligence from the government to ensure we stay alert to any changes.	An increased threat level could increase costs by up to £50m.
Effectiveness of demand management – we have also assumed that under a fast technology scenario, rapid implementation of the demand management strategy will yield a similar total benefit and customer response to stimulus will remain constant.	**WRMP** - this is based on an agreed commonality across WRSE companies, with no contrary evidence found to date.	Given the low level of existing data in this area, a plausible range of variance around this assumption cannot be established.
Co-investment and co-delivery market remains for biodiversity schemes – stakeholder groups will continue to support joint efforts in schemes with non-statutory drivers (e.g. 25 Year Environment plan).	**WINEP WFD & biodiversity** – we plan to work with our communities, catchment partnerships, river groups, EA and environmental NGOs and assume co-investment, co-delivery to maximise the benefits biodiversity schemes and catchment initiatives including management of our designated sites.	Third party contributions are forecast at approximately £14.5m over the LTDS period.

Table 12: Key assumptions and uncertainties

Details of our seven investment strategies

1.1 WINEP – biodiversity

Our ambition for biodiversity

Our ambition for our biodiversity pathway (WINEP and non-WINEP) seeks to deliver the ambitions in our SDS[6]; leave the environment in a sustainable and measurably improved state and deliver a net gain in Natural Capital. We must meet our obligations under the Water Industry Strategic Environmental Requirements (WISER)[7] in addition to other current and future legislative requirements. We will also support the ambition of the 25 Year Environment Plan[8] wider environmental outcomes, specifically improvements to the natural environment, achieving Net Zero carbon outcomes, and contributions to improving access to, amenity of, and engagement with the natural environment to support customer and community wellbeing.

What our customers and stakeholders say

Customers support us increasing biodiversity – they support us doing more than what is 'just required'.[9],[10] During our preferences research with household customers, they chose an environmental option that not only achieved the statutory minimum in terms of reducing abstraction reduction but one with the added benefits of additional catchments undergoing ecological and biodiversity improvements. Non-household customers, however, largely prefer maintaining the status quo.[6], [11] The desire to increase biodiversity is further supported by research we conducted considering large infrastructure schemes. Customers support increasing biodiversity and improving the environment.[12] Households' average valuation of any project addition was considerably higher in the environmental area (£3.05 annually), compared to the economic area (£1.19) and the social area (£1.16) demonstrating the preference from our customers to focus on environmental benefits.

Our strategy & core pathway for biodiversity

Our strategy to deliver our ambition for WINEP biodiversity is presented in Table 13.

INNS Management	Multi-AMP programme agreed with the Environment Agency (EA) and Natural England (NE) to identify and manage INNS on our company sites, alongside partners such as the Wildlife Trust and river groups to tackle wider INNS challenges, including future INNS arising from climate change, in the catchments in which we operate. Continue to review, assess and implement Biosecurity measures on all sites.
Biodiversity management and enhancement on company-owned land	Development and implementation of management plans for each site based on the biodiversity baseline carried out between 2020 - 2025. Identify priority sites for enhancement with key stakeholders. Meet biodiversity performance commitment for 2025-2030 (and equivalent for future periods) for the biodiversity improvements against baseline across our landholdings. Seek further opportunities to provide additional public access to sites to help meet wider objectives/WISER expectations.
Eel and fish screens including options appraisals	Carry out an options appraisal in AMP8 for upgrading screens at Walton Water Treatment Works in AMP9, to ensure they meet best practice requirements. Monitoring and assessment of the effectiveness of screens at our other intakes and upgrade as required.
Third party land biodiversity schemes	Work with key stakeholders, including the Wildlife Trusts, to identify opportunities for biodiversity enhancements on third party land. Support, deliver and co-fund measures where positive contributions can be made to Nature Recovery Network, Local Nature Recovery Strategy plans[13], connect wildlife corridors, protect, and enhance Site of Special Scientific Interest (SSSI) and other designated sites, as well as priority species.

Table 13: Our strategy to deliver our ambition for WINEP biodiversity

[6] Our Strategic Direction Statement 2025–2050 (2021). Available from: https://www.affinitywater.co.uk/docs/corporate/plans/strategic/AW0031_Strategic-direction-statement.pdf

[7] Water industry strategic environmental requirements (WISER): technical document (2022). Available from: https://www.gov.uk/government/publications/developing-the-environmental-resilience-and-flood-risk-actions-for-the-price-review-2024/water-industry-strategic-environmental-requirements-wiser-technical-document

[8] A Green Future: Our 25 Year Plan to Improve the Environment (2018). Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/693158/25-year-environment-plan.pdf

[9] Report 134 – PR24 Customer Engagement, Impact MR 12/09/22

[10] Report 200 – Customer Priorities for Long Term Ambitions – Qual Report, ICS 16/11/22

[11] Report 207 – Customer Priorities for Long Term Ambitions – Quant report, Eftec 19/05/23

[12] Report 153 – Customer preferences on added value for large resource schemes, Accent/ PJM Economics 31/06/22

[13] Local Nature Recovery: more information on how the scheme will work (2022). Available from: https://www.gov.uk/government/publications/local-nature-recovery-more-information-on-how-the-scheme-will-work/local-nature-recovery-more-information-on-how-the-scheme-will-work

Our integrated asset management approach includes biodiversity considerations like invasive non-native species (INNS) control, habitat enhancement, and management, integrated into all asset functions. We continuously refine processes to align with biodiversity legislative requirements, ensuring decisions, projects, and estate management embrace biodiversity needs and demonstrate best practice.

This pathway is 'no regrets' because early investments do not preclude future delivery and implementation changing to address risks, challenges and opportunities that arise up to 2050 and beyond. Schemes will be delivered in order of priority and feasibility so that a flexible approach can be taken to achieve the overall aims. Aligned with WISER expectations and legislation[14];[15];[16];[17];[18];[19], this programme covers current and future requirements. The schemes are adaptable to working with stakeholders and delivery partners, meet wider environmental targets/objectives, and leveraging other benefits within the best value option, delivered in-house, via frameworks or by aiding external partners. To meet our long-term ambition, we propose to make the investments listed below:

Costs (£m)	2025 - 2030	2030 - 2035	2035 - 2040	2040 - 2045	2045 - 2050
INNS Management	2.190	5.429	5.429	5.429	5.429
Biodiversity Management & enhancement on company-owned land	5.725	4.978	4.978	4.978	4.978
Eel and fish passes (Funding support for EA Fish Passage Improvement Scheme)	0.489	-	-	-	-
Eel and fish screens including options appraisals.	0.307	2.172	10.858	-	-
Third party land biodiversity schemes	1.767	1.415	1.415	1.415	1.415

Table 14: Proposed enhancement investments

Investment sequencing between 2025 and 2050 has been determined by the following:

- Our environmental destination strategy for our region included in our rdWRMP
- Ongoing surveys, monitoring, and assessment of our sites for biodiversity net gain with measures driven by the outcomes of the baseline surveys between 2020 and 2025.
- Outcomes of the WINEP investigations across each Asset Management Period (AMP) cycle with associated schemes agreed, costed, and implemented as part of each future WINEP iteration.
- Discussion and agreement with the EA and Natural England (NE) alongside wider stakeholder consultation to develop, define and agree the WINEP WFD programme each AMP.
- Alignment with the WISER expectations.
- Nature recovery network objectives.
- Measures/sites identified under local nature recovery strategies.

Beyond 2050, a comprehensive consideration of various challenges becomes imperative. According to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) [20], ongoing negative trends in nature are projected until 2050, except with transformative changes. Key points from this report pertain to climate change, posing threats through temperature shifts, erratic weather, and sea level rise that disrupt ecosystems locally and globally.

Addressing these issues necessitates collaboration with entities like the EA, NE, and Wildlife Trusts. Our partnerships aim to enhance biodiversity resilience by safeguarding against climate-related impacts and habitat loss due to urban expansion, through preserving existing habitats, fostering wildlife corridors, and boosting genetic diversity.

[14] Natural Environment and Rural Communities Act (2006). Available from: https://www.legislation.gov.uk/ukpga/2006/16/contents
[15] Wildlife and Countryside Act (1981). Available from: https://www.legislation.gov.uk/ukpga/1981/69
[16] Environment Act (2021). Available from: https://www.legislation.gov.uk/ukpga/2021/30/contents/enacted
[17] Water Industry Act (1991). Available from: https://www.legislation.gov.uk/ukpga/1991/56/contents
[18] The Conservation of Habitats and Species Regulations (2010). Available from: https://www.legislation.gov.uk/uksi/2010/490/contents/made
[19] The Water Environment (Water Framework Directive) (England and Wales) Regulations (2017). Available from: https://www.legislation.gorkv.uk/uksi/2017/407/contents/made.
[20] IPBES (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. S. Díaz, J. Settele, E. S. Brondízio, H. T. Ngo, M. Guèze, J. Agard, A. Arneth, P. Balvanera, K. A. Brauman, S. H. M. Butchart, K. M. A. Chan, L. A. Garibaldi, K. Ichii, J. Liu, S. M. Subramanian, G. F. Midgley, P. Miloslavich, Z. Molnár, D. Obura, A. Pfaff, S. Polasky, A. Purvis, J. Razzaque, B. Reyers, R. Roy Chowdhury, Y. J. Shin, I. J. Visseren-Hamakers, K. J. Willis, and C. N. Zayas (eds.). IPBES secretariat, Bonn, Germany. 56 pages. https://doi.org/10.5281/zenodo.3553579

INNS will continue to be a major issue beyond 2050. There are currently over 2000 non-native species (NNS) already established in the UK and of the 10 to 12 new NNS that arrive in the UK each year, at least one is predicted to become invasive, compounding the issue.

Anticipated pollution escalation from climate change, population growth, and agricultural practices poses a further threat. To mitigate this, alignment with the WINEP pathway is key. We commit to reducing our own pollution footprint while engaging with various stakeholders to minimise broader water and land pollution.

Compliance with the Eels Regulations and Salmon and Freshwater Fisheries Act and other relevant legislation for the protection of fish is integrated into our strategy, considering our four intakes on the River Thames. As other fish passage and habitat improvements are made along the river, we must invest in intake modifications to align with evolving best practices and regulations.

As seen in the appendices, scenario testing confirms the resilience of our core pathway against the common reference scenarios such that no alternative pathways are required under the plausible future scenarios.

Additional benefits from core pathway for future scenarios

This pathway will seek to protect and restore important habitats for biodiversity, both within our landholdings and on third party land. Alongside effective INNS management this will create an environment more resilient to climate change and population growth while offsetting wider negative impacts and achieving a net gain in Natural Capital through our Nature Positive Strategy.

Core pathway activities to safeguard future options

Investment in this pathway is all low regrets. There is no planned investment in potential regret areas and would only be required under adverse scenarios.

Rationale of biodiversity

Identification of core and alternative pathways

We have identified and selected options based on experience from our AMP6 and AMP7 biodiversity programmes and insights from delivering catchment and nature-based solutions (C&NBS) measures through the WINEP in AMP7, as well as considering the expectations of our regulators set out in the WISER.

The pathway developed has been guided by the expectations of our regulators including: the government's 25 Year Environment Plan[21] and Defra's Integrated Plan for Delivering Clean and Plentiful Water[22], long-term water resources Environmental Destination guidance from EA, WISER, EA/Ofwat expectations for the adoption and implementation of C&NBS, 2025 - 2030 biodiversity performance commitment, Biodiversity Net Gain, PR24 WINEP methodology, and the Natural Environment and Rural Communities (NERC) Act, Wildlife and Countryside Act, the Eels Regulations and Salmon and Freshwater Fisheries Act.

We followed a structured optioneering process to identify a wide range of potential options in our unconstrained list. Evaluating against WINEP coarse screening criteria and Ofwat's requirements, we reined this into a shorter, constrained list. Constrained options underwent comprehensive analysis via our options evaluation spreadsheet, scoring against varied criteria to determine acceptable options. Further refinement included developing hybrid solutions by amalgamating optimal components from work packages, ensuring technical viability, to produce a feasible list. The list ultimately yielded our best value option.

[21] A Green Future: Our 25 Year Plan to Improve the Environment (2018). Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/693158/25-year-environment-plan.pdf

[22] Plan for Water: our integrated plan for delivering clean and plentiful water (2023). Available from: https://www.gov.uk/government/publications/plan-for-water-our-integrated-plan-for-delivering-clean-and-plentiful-water/plan-for-water-our-integrated-plan-for-delivering-clean-and-plentiful-water

The biodiversity measures for each AMP of the LTDS period will be developed using this optioneering approach. This strategic approach, shaped through the WINEP process, will identify the issues to be addressed, their scale, the required measures and forecast wider environmental benefits of those measures e.g., Biodiversity Net Gain and carbon sequestration. Costs stem from our extensive experiences between 2015 and 2025, shaping our PR24 unit cost model validated through third-party quotes, aiding accurate cost estimation, and identifying opportunities for efficiencies.

Foundations of biodiversity

Assumptions

We assume that there will be an ongoing 10% BNG requirement for future developments, for the duration of the LTDS, under a regulatory expectation of us to protect and enhance biodiversity across our landholdings. We also assume that the biodiversity measures will continue to be required and funded through the WINEP for the duration of the LTDS.

We assume that legislative requirements for eel and fish screens will evolve over time and have allowed investment for this. The current Eels Regulation exemption notice for Walton Water Treatment Works (WTW) expires in 2030, so we expect to invest further at this site at that time.

We plan to work with our communities, catchment partnerships, river groups, EA and environmental NGOs and assume co-investment and co-delivery to maximise the benefits of biodiversity schemes including management of our designated sites.

We assume that INNS issues will persist for the duration of the LTDS, with emerging and future INNS becoming more likely to require investment[23,24].

Performance improvements from base expenditure

Increased management of our landholdings for biodiversity and addressing the presence of INNS may reduce base costs associated with ground maintenance activities. Improved efficiency and design of fish screening may reduce the need for manual maintenance at intake structures where screen washing processes can be optimised.

Uncertainties

Throughout the LTDS duration we will assess the impacts on habitats and biodiversity from changes in land use, climate change and population growth. These will be determined through the WINEP process each AMP.

The required investment to meet our BNG targets and future performance commitments is not fully understood. This will be assessed through repeated surveying of company owned land, recommendations from our in-house ecology team and external experts.

Future legislative requirements and associated investments required to ensure eel and fish screens are compliant are not fully understood but will be planned and delivered through the WINEP cycle. The selected adaptive pathway of the WRMP will affect the pace and scale of the WINEP biodiversity pathway and associated investment.

While our approach remains consistent, site assessments will tailor BNG-focused management and habitat creation, costed as needed for each business plan.

Uncertainties that cannot meaningfully be alleviated

All uncertainties can be meaningfully alleviated. However, under an extreme climate change scenario the scale and extent of biodiversity degradation may be such that resilience measures may not be effective.

[23] UKWIR project 16/DW/02/82 INNS Implications on the Water Industry Project

[24] IPBES (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. S. Díaz, J. Settele, E. S. Brondízio, H. T. Ngo, M. Guèze, J. Agard, A. Arneth, P. Balvanera, K. A. Brauman, S. H. M. Butchart, K. M. A. Chan, L. A. Garibaldi, K. Ichii, J. Liu, S. M. Subramanian, G. F. Midgley, P. Miloslavich, Z. Molnár, D. Obura, A. Pfaff, S. Polasky, A. Purvis, J. Razzaque, B. Reyers, R. Roy Chowdhury, Y. J. Shin, I. J. Visseren-Hamakers, K. J. Willis, and C. N. Zayas (eds.). IPBES secretariat, Bonn, Germany. 56 pages. https://doi.org/10.5281/zenodo.3553579

1.2. WINEP – Drinking Water Protected Areas (Schemes)

Our ambition for Drinking Water Protected Areas (Schemes)
Our ambition is to enhance Drinking Water Protected Areas (DrWPAs) through a 25-year catchment and nature-based solutions (C&NBS) programme. This initiative aims to reduce pollution risks e.g., pesticides and nitrates in the DrWPA of our River Thames abstractions, while fostering biodiversity and Net Zero benefits alongside wider benefits like soil health.

This programme of C&NbS, delivered over the next 25 years, will support our SDS ambitions of:

- **Environment. Leave the environment in a sustainable and measurably improved state.** This will be achieved through partnership working to implement C&NbS will protect and enhance raw water quality and contribute to water under the Water Framework Directive (WFD) while supporting the 25 Year Environment Plan and the Defra 'Plan for Water.'
- **Resilience**. **Be prepared for change, and resilient to shocks and stresses.** This programme will support this through reduced raw water deterioration and providing greater resilience to our water treatment work processes.

Our ambition also entails meeting regulator expectations such as Ofwat's Public Value Principles, EA and Natural England's WISER, and Drinking Water Inspectorate's long-term planning guidance. We are dedicated to achieving our Net Zero commitments and quantifying ecosystem services benefits through C&NbS, aiding biodiversity and climate regulation.

What our customers and stakeholders say
Customers have expressed strong support for our environmental ambitions, going beyond the statutory minimum, although there was no preference for any specific plan. Customers support our WINEP but consider this to be the baseline required. However, support for environmentally focused initiatives is counterbalanced by cost concerns and the demand for verifiable investment.

Our strategy & core pathway for DrWPA Schemes
We will deliver C&NbS measures in our DrWPA catchments in partnership with neighbouring water companies, creating more sustainable and resilient catchments in the Thames River Basin District. C&NbS measures will mitigate pollution risks through identification of sources, improving water quality and soil health, increase drought and flood resilience, enhance biodiversity, capture carbon, and enhance water resources in chalk stream catchments.

The investments are shown in Table 15.

These enhancement expenditure activities will include a programme of spatially and temporally targeted land management measures that include:

- Catchment pollutant sampling, modelling, monitoring and source apportionment.
- Ongoing development of our pollutant time of travel modelling for pollution incidents.
- Funded and incentivised C&NbS land management measures that can mitigate raw water deterioration risks.
- Support amenity and agricultural activities to encourage uptake of precision farming techniques to minimise losses into the environment and raw water deterioration.
- Encourage uptake of low input, regenerative agriculture measures that reduce the losses of soil, sediment and contaminants into water. This will also seek to reduce the levels of eutrophication and associated algal

blooms in waterbodies and reduce environmental impact of farming activities.

- Partnership working with Thames Water and South-East Water to share knowledge, resources and research to deliver C&NbS across a larger geographical area.
- Identification of future DrWPA's resulting from emerging SROs and associated pollution mitigation programmes.
- Provide technical support and facilitation investment to partners, including catchment partnerships, to support Defra's catchment-based approach.

Our integrated approach to asset management will incorporate DrWPA requirements into all asset functions. We continuously refine our processes to align to legislation, utilising our environmental monitoring network to assess benefits and inform future investment decisions.

This pathway is 'no regrets' because the delivery and implementation are adaptive and can change to address risks, challenges and opportunities that arise up to 2050 and beyond. It assumes that schemes will be delivered in order of priority and feasibility so that a flexible approach can be taken to achieve the overall aims.

To meet our long-term ambition, we propose to invest the following over the next five AMPs.

Lead timing (Years)	2025 - 2030	2030 - 2035	2035 - 2040	2040 - 2045	2045 - 2050
Delivery timing	2025-30	2030-35	2035-40	2040-45	2045-50
Estimated cost (£m)	3.442	5.458	5.530	5.412	5.568

Table 15: Key enhancement investments, costs, lead timing and delivery timing

Investments have been sequenced based on the Drinking Water Safety Plan (DWSP) catchment risk assessments and monitoring programmes, our understanding of risks, the outcomes of the WINEP investigations and WISER[25]. Continuous develop of the plan across the LTDS duration will be carried out in agreement with the EA, DWI and wider stakeholders.

Investments into C&NbS to reduce water quality risks in our DrWPA catchments will help mitigate raw water deterioration risks, particularly in the Lower Thames DrWPA. The criticality of our River Thames abstractions increases as a consequence of the reduction in groundwater abstraction due to sustainability reductions. We therefore need to ensure raw water quality is protected from remaining sources.

Co-investment and co-delivery mechanisms such as catchment ecosystem services trading, BNG and carbon reduction measures could help reduce the cost of future options and increase their benefits.

Our rdWRMP includes reduction in abstraction from chalk groundwater sources balanced by greater reliance on new SROs. The DrWPAs for these new surface water sources will require more catchment-based interventions to safeguard against raw water deterioration.

The WINEP DrWPA pathway will implement integrated C&NbS to mitigate the raw water deterioration impacts of climate change. This adaptive approach aligns with the 25 Year Environment Plan[26] and Plan for Water[27],

[25] Water industry strategic environmental requirements (WISER): technical document (2022). Available from: https://www.gov.uk/government/publications/developing-the-environmental-resilience-and-flood-risk-actions-for-the-price-review-2024/water-industry-strategic-environmental-requirements-wiser-technical-document

[26] A Green Future: Our 25 Year Plan to Improve the Environment (2018). Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/693158/25-year-environment-plan.pdf

[27] Plan for Water: our integrated plan for delivering clean and plentiful water (2023). Available from: https://www.gov.uk/government/publications/plan-for-water-our-integrated-plan-for-delivering-clean-and-plentiful-water/plan-for-water-our-integrated-plan-for-delivering-clean-and-plentiful-water

working in partnership with wider sectors and stakeholders and scaling up as required. We will monitor and report progress through the WINEP programme and alongside our revised Climate Change Adaptation Report.

The European Union Joint Research Centre (JRC)[28] predicts intense rainfall eroding agri-soils by 2050, escalating pesticide/nutrient loss risks, flood risk, and raw water deterioration. The C&NbS programme will help mitigate these climate change related risks, adapting throughout the LTDS to use nature-based solutions to reduce expensive, carbon-intensive infrastructure needs.

Our WRMP forecasts significant population growth up to 2075 with uncertainties of scale necessitating an adaptive management pathway. Significant growth and associated development will be in the Thames River Basin, requiring interventions through the WFD pathway to mitigate the risks and impacts of these developments and support more sustainable and resilient catchments for water.

Nationally significant infrastructure projects (including HS2, Heathrow expansion and Lower Thames Flood Alleviation) are planned in our DrWPA's during the LTDS timeframe resulting in risks and impacts beyond 2050, such as deteriorating water quality and flows in the River Thames. Our Environmental Strategy and Planning teams will work closely with developers and regulators to define, model, monitor and mitigate these risks. In testing our core pathway against the Ofwat reference scenarios we found no material impact that would require an alternative pathway. Following this testing we are confident that our core pathway is sufficiently resilient against various futures.

Additional benefits from core pathway for future scenarios

This pathway will seek to work with land managers in our DrWPAs to create more sustainable and resilient catchments for water supply, food production and the wider environment. Targeted C&NbS will mitigate the impacts and associated costs of climate change and will mitigate future costs associated with raw water deterioration and Net Zero pathways.

Core pathway activities to safeguard future options

Investment in this pathway is all 'low regrets.' There is no planned investment in potential regret areas and would only be required under adverse scenarios.

Rationale of Drinking Water Protected Areas (Schemes)

Identification of core and alternative pathways

Options have been identified and selected based on our catchment risk assessments and previous WINEP investigations and schemes delivered between 2015 and 2025. This is supplemented with evidence from existing catchment monitoring programmes to determine the scope and targeting of options and informing, alongside evidence of water quality risks, long term trends and historic outages on the River Thames.

The pathway developed has been guided by the expectations of our regulators including: the government's 25 Year Environment Plan[29] and Defra's Integrated Plan for Delivering Clean and Plentiful Water[30], long-term water resources Environmental Destination guidance from EA, WISER[31], DWI long term planning guidance for drinking water, EA/Ofwat expectations for the adoption and implementation of C&NbS and PR24 WINEP methodology.

[28] Maréchal, A; Jones, A.; Panagos, P. Belitrandi, D.; De Medici, D.; De Rosa, D.; Jiminez, J.M.; Koeninger, J.; Labouyrie, M., Liakos, L.; Lugato, E.; Matthews, F.; Montanarella, L.; Muntwyler, A.; Orgiazzi, A.; Sca rpa, S.; Schillaci, C.; Wojda, P.; Va n Liedekerke, M.; Vieira, D. EU Soil Observatory 2021. EUR 31152 EN, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-55031-0, doi:10.2760/582573, JRC129999

[29] A Green Future: Our 25 Year Plan to Improve the Environment (2018). Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/693158/25-year-environment-plan.pdf

[30] Plan for Water: our integrated plan for delivering clean and plentiful water (2023). Available from: https://www.gov.uk/government/publications/plan-for-water-our-integrated-plan-for-delivering-clean-and-plentiful-water/plan-for-water-our-integrated-plan-for-delivering-clean-and-plentiful-water

[31] Water industry strategic environmental requirements (WISER): technical document (2022). Available from: https://www.gov.uk/government/publications/developing-the-environmental-resilience-and-flood-risk-actions-for-the-price-review-2024/water-industry-strategic-environmental-requirements-wiser-technical-document

We followed a structured optioneering process to identify a wide range of potential options in our unconstrained list. Evaluating against WINEP coarse screening criteria and Ofwat's requirements, we reined this into a shorter, constrained list. Constrained options underwent comprehensive analysis via our options evaluation spreadsheet, scoring against varied criteria to determine acceptable options. Further refinement included developing hybrid solutions by amalgamating optimal components from work packages, ensuring technical viability, to produce a feasible list. The list ultimately yielded our best value option.

The best value option is developed based on experience of the WINEP development process between 2015 and 2025, assuming similar processes and regulatory requirements in the future. Costs stem from our extensive experiences between 2015 and 2025 shaping our PR24 unit cost model validated through third-party quotes, aiding accurate cost estimation and identifying opportunities for efficiencies.

This option seeks to deliver a holistic programme of prioritised and spatially targeted C&NBS which addresses the current and future risks and issues. This will include investigations and C&NBS schemes to prevent deterioration of 'at risk' pesticides and monitor the risk of emerging pesticides, reduction of sediment and nutrient losses, protecting and restoring natural assets to improve catchment resilience and delivering benefits for water quality, resources, climate change regulation and biodiversity.

The risks and issues to be mitigated, alongside the types of measures that will be developed for each WINEP/AMP cycle throughout the LTDS life cycle will be agreed through the WINEP process based on the key issue the schemes need to address e.g., pesticide, the scale of the issue (number/size of catchment affected) and benefits assessment of the measures proposed in delivering wider environmental benefits, e.g., carbon sequestration. Estimated costs for the chosen option have been based on the extensive experience gained from developing and delivering DrWPA C&NbS schemes with successful outcomes during 2015 and 2025.

Foundations of Drinking Water Protected Areas (Schemes)

Assumptions

We assume that Environmental Destination requirements and WRMP will be required for the duration of the LTDS, and that the driver for C&NbS will be maintained beyond the current WFD period of 2030, and long-term planning across multiple sectors replies on C&NbS. We have also assumed that customers and regulators will continue to support investment in C&NbS beyond 2025 - 2030 based on the current regulatory guidance.

We assume that catchment-based interventions will be required to safeguard River Thames water quality as our reliance on this source grows.

We assume that there will be an increase in chemical or fertiliser use by farmers and land managers to address increased risk of pests and diseases and loss of nutrients through increased runoff due to climate change, requiring C&NbS to mitigate the effects.

An increased regulatory/government focus on the use of NbS will lead to increased academic research, investment in and adoption of C&NbS measures over time.

We will work with our communities, catchment partnerships, river groups, EA, neighbouring water companies and environmental NGOs to co-invest, co-deliver and maximise the benefits of environmental schemes (C&NbS) to achieve common ambitions.

Performance improvements from base expenditure

Effective management of pollution risks and impacts to raw water through this pathway in our catchments at their source, rather than solely depending on treatment will enable more efficient management of our treatment processes and consistency in performance. This, over the life of the LTDS, should lead to performance improvements from our base expenditure through reduced energy consumption and associated carbon; reduced frequency of activities such as GAC regeneration/replacement

and the reduced likelihood of utilisation of imports and redistribution of water (associated energy and carbon costs) through reductions in pollution events limiting our ability to abstract from the DrWPA's. C&NbS within the catchments of our surface water sources also has the potential to reduce flood risk to our assets and wider communities.

Uncertainties

Our rdWRMP24 has four adaptive management pathways to account for uncertainties. The pace and scale of the WINEP DrWPA pathway and investment will develop in line with the WINEP programme. The expenditure required for the programme may change as a result of abstraction reductions, development of new sources and C&NbS implementation programmes.

Uncertainties that cannot meaningfully be alleviated

Types of pollution related risks that have yet to be identified and changes in land use and associated pollutants will be determined throughout the LTDS life cycle through the DWSP risk assessments, catchment and abstraction monitoring programmes and future WINEP investigations and schemes. The pace of delivery of CSO programmes for WaSC's and associated nutrification and microbiological contamination of DrWPA is also unknown. As part of the wider WINEP programme, we will work closely with neighbouring water companies to understand and mitigate associated wastewater quality risks in the DrWPA catchments.

Based on these uncertainties, our strategy will remain focussed on the most effective measures building on experience and evidence, but the focus, scale, and type of C&NbS measures deployed will be determined by the issues the pathways are seeking to mitigate throughout the LTDS life cycle.

1.3. WINEP – Water Framework Directive

Our ambition for Water Framework Directive

Chalk streams, exclusively found in Northwest Europe, with more than 85% found in England (10% in our supply area) are globally rare and important habitats, sometimes described as 'England's rainforests'. They provide a range of ecosystem services including recreation and health benefits. Our groundwater abstraction for potable supply has the potential to impact chalk streams and their Water Framework Directive (WFD) status. However, the impacts and mechanisms behind them are complex, and one of a number of factors which can impact the health of chalk streams (other factors include river morphology, land use, water quality and discharges and drought). We have a substantial environmental monitoring network and work collaboratively with the EA to understand the impact of our abstractions on chalk streams, so that we can take decisions to help protect this precious resource.

Defra's Plan for Water[32] highlights the impact of abstraction on chalk streams and focuses on reducing chalk stream catchment abstractions through the EA's Restoring Sustainable Abstraction[33] and the Water Industry National Environment Programme (WINEP)[34]. Our WFD LTDS pathway aligns with this, featuring nature-based solutions, infrastructure investment, and community collaboration to achieve resilience chalk stream catchments, consistent with our SDS[35] goal of ending unsustainable chalk groundwater abstraction where this is proven.

This aligns with regional water resource management plans (Water Resources East and Water Resources South-East) and our WRMP[36], and our environmental destination' strategy for sustainable abstraction under the 25

[32] Plan for Water: our integrated plan for delivering clean and plentiful water (2023). Available from: https://www.gov.uk/government/publications/plan-for-water-our-integrated-plan-for-delivering-clean-and-plentiful-water/plan-for-water-our-integrated-plan-for-delivering-clean-and-plentiful-water

[33] Water abstraction plan: Environment (2021). Available from: https://www.gov.uk/government/publications/water-abstraction-plan-2017/water-abstraction-plan-environment

[34] Water Industry National Environment Programme (2022). Available from: https://www.data.gov.uk/dataset/a1b25bcb-9d42-4227-9b3a-34782763f0c0/water-industry-national-environment-programme

[35] Our Strategic Direction Statement 2025–2050 (2021). Available from: https://www.affinitywater.co.uk/docs/corporate/plans/strategic/AW0031_Strategic-direction-statement.pdf

[36] Water Resources Management Plan (2020)

Year Environment Plan[37]. This approach helps align our activities to be consistent with emerging governmental policy, water resources availability, provide resilience benefits to people, businesses and the environment and ensure our future prosperity in a climate-affected world.

What our customers and stakeholders say
Customers predominantly support reducing groundwater abstraction from chalk stream catchments, despite it being a lower national priority. Locally, chalk stream importance is recognised; environmental improvement ranks 4th out of 11 options, with most customers favouring maximum investment to curb abstraction and restore rivers. Future customers, particularly, want to surpass minimum standards. While there is strong support for additional costs, non-household customers are more hesitant (AFW04).

Our strategy & core pathway for Water Framework Directive
The core pathway will deliver a multi-AMP programme of abstraction impact assessments (investigations) through the WINEP. The investigations will inform the future chalk catchments sustainability reductions (SR) programme as per our WRMP. This aligns with a parallel programme of catchment and nature-based solutions (C&NBS) including catchment management, environmental monitoring, river morphology improvement works and habitat enhancement.

Meeting the Environmental Destination' through the WFD pathway will be delivered through a holistic programme of measures, with descriptions, costs and scheduling shown below:

- **WINEP investigations**

Abstraction impact assessments and options appraisals will be agreed with the EA and Natural England through the WINEP, including assessment of emerging risks to raw water deterioration to determine the need for targeted catchment and nature-based solutions.

- **Sustainability reductions**

Measures including ceasing and/or reducing abstraction and no deterioration abstraction licence capping of chalk groundwater sources, alongside investments in our infrastructure, aligned with the EA through the Restoring Sustainable Abstraction programme. All sustainability reductions include provision for investigations to ensure no increased risk of groundwater emergence, flood risk or decrease of groundwater quality as a result of the abstraction reduction.

- **Flagship Chalk Stream Catchment Restoration Project**

A pilot project delivered through 2025 - 2035 plans to realise the ambition of Defra's Catchment Based Approach38 Chalk Stream Restoration Strategy and Implementation Plan. The project will be delivered on the River Beane in partnership with key stakeholders.

- **River restoration, river improvement works and habitat enhancements**

Improving flow and creating/enhancing habitats in chalk stream habitats also improves resilience to climate change, drought, pollution events and other anthropogenic factors. These measures will help contribute to achieving Good Ecological Status (GES) or Good Ecological Potential (GEP).

- **Catchment and nature-based solutions (C&NBS)**

C&NbS measures are an integrated approach to creating more sustainable and resilient catchments for water and the wider environment. Our C&NbS measures will mitigate diffuse and point source rural and urban pollution to improve water quality, increase drought and flood resilience, enhance biodiversity, capture carbon, and enhance water resources in chalk stream catchments.

[37] A Green Future: Our 25 Year Plan to Improve the Environment (2018). Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/693158/25-year-environment-plan.pdf

[38] Catchment Based Approach: Improving the quality of our water environment (2013). Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/204231/pb13934-water-environment-catchment-based-approach.pdf

Our experienced and dedicated in house team of experts (water resource experts, project managers, catchment scientists, agricultural advisors, hydrogeologists, and ecologists) will use environmental monitoring and baseline data to continually identify risks, develop scope and assess benefits to inform future decisions.

This pathway is "no regrets" because the delivery and implementation are adaptive and can change to address risks, challenges and opportunities that arise up to 2050 and beyond. It assumes that schemes will be delivered in order of priority and feasibility so that a flexible approach can be taken to achieve the overall aims. Investing in C&NbS to create more sustainable and resilient catchments may help to mitigate the need for future expensive infrastructure.

Co-investment and co-delivery mechanisms such as catchment ecosystem services trading, BNG and carbon reduction measures could minimise the cost of future options. We will use wider private sector finance to reduce future costs.

Lead timing	2025 - 2030	2030 - 2035	2035 - 2040	2040 - 2045	2045 - 2050
Delivery timing	2025-2030	2030-2035	2035-2040	2040-2045	2045-2050
Estimated cost (£)	152.050	177.584	160.744	184.919	176.302

Table 16: Proposed enhancement investments (£m)

The investments have been sequenced to meet best value planning as set out in our rdWRMP through discussions with the EA, alongside wider stakeholder consultation, and based on outcomes of the WINEP investigations across each AMP cycle.

Our core pathway aligns with our adaptive management approach in the rdWRMP, with investments tailored accordingly. Our measures will mitigate climate change effects, adapting to likely scenarios post-2050. Collaborating with wider sectors and stakeholders, our catchment-based approach, complemented by Defra's 25 Year Environment Plan and Plan for Water, can adjust to climate pressures. Monitored through the WINEP programme and Climate Change Adaptation Report, our plans remain dynamic through the LTDS and beyond.

Population growth and development in chalk stream catchments pose significant pressures up to 2050 and beyond. Our WRMP forecasts such growth up to 2075, shaping our adaptive management pathway. Much growth will occur in these areas, driving interventions like new SRO's and C&NbS via the WFD pathway to enhance our supply resilience.

Climate-induced land use shifts, e.g., in farming, may increasingly impact chalk stream and groundwater quality post-2050. The EU Joint Research Centre predicts soil erosion (13-23% by 2050) and runoff escalation, intensifying pesticide/nutrient losses into the environment and increasing flooding risks. C&NbS and river restoration will help mitigate these impacts sustainably, potentially reducing the need for carbon-intensive and costly infrastructure while adapting to changes and leveraging nature-based solutions.

Scenario testing confirms the resilience of our core pathway against the common reference scenarios such that an alternative pathway is only required under the abstraction reduction scenario (see Appendix).

Additional benefits from core pathway for future scenarios

Investments in our infrastructure from our SRs, alongside the implementation of key SROs will provide greater flexibility in the distribution of potable water across our network, mitigating climate-change and growth risks, particularly during periods of high demand (the summer).

This pathway will seek to work with landowners and managers in our WFD catchments to create more sustainable and resilient catchments for water supply, food production and the wider environment. Our river restoration programme alongside our SRs will provide greater resilience to chalk

streams in our supply area from the climate change and population growth scenarios. Spatially and temporally targeted C&NbS will help mitigate the impacts and associated cost of climate change and should help manage future costs associated with the raw water deterioration and Net Zero pathways through reduction of long-term treatment Capex and Opex costs.

Alternative pathways for WINEP Water Framework Directive

Abstraction reduction:
Abstraction reductions have been determined sufficiently material to require an alternative pathway, which is shown in Table 17.

Decision point	(i) 2028 WRMP and WINEP investigations resulting in change to Sustainable Abstraction programme in agreement with the Environment Agency
Trigger point	2030 - WRMP and WINEP investigations resulting in change to Sustainable Abstraction programme in agreement with the Environment Agency
Point in which the pathway deviates	(i) 2030

Table 17: Decision point, Trigger point and Point in which the pathway deviates for the alternative pathway in the abstraction reduction scenario

	2025 -30 (£m)	2030 -35 (£m)	2035 -40 (£m)	2040 -45 (£m)	2045 -50 (£m)
Additional enhancement activity (Water enhancement expenditure by purpose totex)	-	44.90	65.680	44.819	174.112

Table 18: Water Framework Directive additional enhancement expenditure – Abstraction Reduction scenario

Core pathway activities to safeguard future options

Investment in this pathway is all 'low regrets'. There is no planned investment in potential regret areas, and this would only be required under adverse scenarios.

Rationale of Water Framework Directive

Identification of core and alternative pathways

The options have been identified and selected based on experience from developing and delivering WINEP investigations, SRs, river restoration and C&NbS measures between 2015 - 2025. They have been selected based on the strategic regional plans and Environmental Destination for our region, and alignment with our Water Resource Management Plan.

As part of each WINEP investigation, an options appraisal is undertaken which informs the optioneering for SRs, river restoration and C&NBS elements of the WFD pathway.

We used Pywr and MISER modelling which identified a series of different time horizons to reflect the key challenges associated with phases of sustainability reductions, Environmental Destination (the reductions needed to ensure abstraction is sustainable, now and in the future), and the delivery of primary and secondary SROs for Affinity Water. This provided the ability to understand the points at which our network is likely to be under the most stress and the modifications and reinforcements required to maintain customer supplies.

Optimizer modelling was used to select the most cost effective and sustainable options to size trunk mains and booster pump assets, identified through the Pywr and MISER modelling outputs. This is supported using Continuum to undertake further optioneering evaluation of infrastructure options and potential risks using a combination of Continuum analysis and in-house assessment using ArcGIS and our Asset Information Centre (AIC). This is complimented using Infoworks (our detailed network model) to carry

out an assessment where more localised network reinforcement would be required.

Optioneering for the parallel programme of C&NbS, alongside Sustainability Reductions, is undertaken following the WINEP development methodology, and supports meeting current and future regulatory requirements (e.g., WISER). The optioneering, based on the outcomes of the associated WINEP investigations will seek to maximise the benefits of the implemented reductions and/or cessation of abstraction to address some of the wider reasons for not achieving good status in the associated chalk stream catchments, as well as addressing current and future raw water deterioration risks.

More details on our Sustainability Reductions optioneering can be found in the Enhancement Business Cases Appendix (AFW14) of our PR24 business plan.

From 2030 onwards, we have costed sustainability reductions based upon average costs per Ml/d of abstraction reduction across programmes spanning 2020 to 2025 and 2025 to 2030. This approach has been taken as exact locations of these abstraction reductions and the associated requirements of the schemes in the future is less clear, partly linked to decision points in 2025 - 2030 and work programmes currently in train to review confidence in Environmental Flow Indicators (EFIs) and update the Environment Agency groundwater models to improve confidence in the outputs. However, programmes during 2020 to 2025 and 2025 to 2030 are likely to be a representative basket of schemes given the comparability in distances and volumes of water to be moved. The significant deviation in volumes of abstraction reductions between high and low scenarios therefore results in a proportional deviation in costs, requiring an alternative pathway.

Foundations of Water Framework Directive

Assumptions

- **WINEP Investigation assumptions**

We have made assumptions regarding the study areas and length of the waterbodies. We identified the surface water catchments and the length of the main waterbodies as the initial delineation reference of investigations. However, the studies are likely to go beyond the catchment watersheds to include all those elements that have potential to influence the natural processes. This is particularly relevant for most of the investigations that involve groundwater elements, as groundwater catchments often differ from topographical catchment areas.

We are not yet able to establish the amount of groundwater abstractions requiring assessment, therefore have assumed this based on the best current knowledge of the needs of our catchments.

The investigations will rely on a series of data that is going to be collected by third parties, mostly the EA. These data collection activities have not been costed, under the assumption that the EA will continue to commit to undertake the field monitoring in line with the current plan for 2020 to 2025.

We have assumed that the EA will continue updating and refining the regional regulatory groundwater model, using a combination of EA and water company monitoring data and analysis. We assume that these models will be made available to us either directly, or through consultant services.

We have assumed we will be given access permission to drill observation boreholes, measure flow in the river and carry out surveys and tests on third party landholdings.

We have assumed that regulatory drivers for the programme of investigations and abstraction reductions under WINEP will continue

beyond 2027, despite this being the original deadline identified for waterbodies to achieve GEP or GES under the WFD.

- **Sustainability Reductions assumptions**

We have assumed that the rdWRMP adaptive management pathway will determine the direction and pace of the WFD pathway, including the SR programme across the life of the LTDS. This will be reviewed as part of the WRMP process and informed by the outcomes of the WINEP investigations.

Implementing SRs alongside our C&NbS will deliver wider benefits to support achieving the outcomes of the 25 Year Environment Plan and support delivery of WFD objectives.

Cost of delivering sustainability reductions per Ml/d has been assumed as constant across the 2030 to 2050 period, at the average unit cost seen from the 2020 to 2025 and 2025 to 2030 programmes.

- **C&NbS/ river restoration assumptions**

We have assumed that the potential responses of farmers and land managers to climate change may be detrimental to both water resources and water quality. However, we have assumed that, over time, there will be an increased understanding and knowledge base for effective options and implementation of C&NbS.

River restoration and C&NBS will continue to be funded through WINEP for the life of the LTDS. They will be delivered alongside SRs and contribute to achieving GES/GEP in chalk streams over the life of the LTDS.

We will work with our communities, catchment partnerships, river groups, EA and environmental NGOs to co-fund, co-deliver and maximise the benefits of environmental schemes (C&NBS/river restoration).

Performance improvements from base expenditure
Through delivery of the sustainability reductions programme as we design and build the new infrastructure and non-infrastructure assets required to facilitate these, we will ensure they allow for improvements in operation and hence base expenditure.

Building greater understanding of our catchments through the monitoring and investigations but also through implementation of C&NbS, we will seek to mitigate catchment risks and create resilient chalk stream catchments. This in turn will create the opportunity for improvements to raw water quality and in the long term seek to reduce end of pipe treatment requirements. C&NbS within the catchments of our surface water sources also has the potential to reduce flood risk to our assets and wider communities, reducing risk of operational outages.

Uncertainties
We are uncertain which course the adaptive management pathway of the rdWRMP will take. Pace and scale of the WINEP WFD pathway and associated investment will be developed accordingly for each WINEP cycle informed by the WINEP investigations and associated monitoring.

We are unsure if there will be a requirement for C&NbS and river restoration in chalk stream catchments where all abstraction is ceased. This will be reviewed and addressed through each WINEP cycle and investment costs, and scale will be managed through regulator dialogue. This will be agreed alongside customer consultation and willingness to pay.

Uncertainties around the affordability and effectiveness of smart technologies to reduce demand over time, and whether the technological developments can occur at a pace, could inhibit our mitigations against the impacts of the climate change scenario.

Although these uncertainties might affect the pace and scale of SR, C&NBS and associated expenditure across each AMP, they will not impact the overall approach of our core pathway.

Uncertainties that cannot meaningfully be alleviated
Due to the interdependencies with other programmes, for example, the WRMP, uncertainties identified for the WFD schemes cannot be considered in isolation. We will continue to monitor and adapt our programmes to ensure that we follow the most beneficial pathway and therefore mitigate the impact of uncertainties.

2. Net Zero

Our ambition for Net Zero
In 2019, the UK government committed to reduce its greenhouse gas emissions by 100% from 1990 levels by 2050. This would require the amount of greenhouse gas emissions produced by the UK to be equal or less than the emissions removed by the UK from the environment. All water companies have a part to play in reaching this commitment. As a stretching interim target, every water company in England and Wales has agreed to a 'Public Interest Commitment', pledge to reach Net Zero for a defined set of operational emissions by 2030.

We are aiming to reach Net Zero emissions (operational and embedded) by 2045 as part of our SDS goals. Our commitment to reduce operational emissions will also require us to reduce the emissions associated with water treatment, often referred to as process emissions.

As the largest water only company, we expect to play a significant role in improving the knowledge of water treatment process emissions specifically. With research being undertaken from 2025 to 2030, we can put in place plans to manage residual process emissions. We are also aiming to reduce our embedded emissions through working with our supply chain and undertaking an approach based upon a PAS 2080 (a standard for managing carbon in building and infrastructure that looks at the whole value chain).

Our Asset Management policy accounts for the importance of delivering our Net Zero ambition, with specific reference to carbon reduction within our asset management objectives. Our commitment to implement PAS 2080 will shape our asset management approach to make carbon a key influence in project design, delivery and in our supply chain.

What our customers and stakeholders say
The link between water and Net Zero is not clear or direct in customers' minds. Concern over carbon emissions is, however, increasing, although customers do balance it with other environmental drivers and there is a price limit for some. Transparency over cost and effectiveness of our solutions will help customers support our approach. Support for green policies and carbon reduction is contingent on cost. In 2016, 12% of customers surveyed, considered it the number one priority. This has since risen with groups such as Extinction Rebellion and the prominence of events like COP 26. There are indications that this importance is falling again in the face of the cost-of-living crisis. Carbon reduction is ranked higher by non-household customers than household customers. This is likely due to the need to meet their own net-zero operational targets. Engagement amongst customers of multiple water companies has suggested that customers are in favour of companies reducing their carbon footprint and using more green energy. This support was contingent on the impact it had on their bills. Customers also wanted the impact on the vulnerable to be considered as part of this. There are some conflicting messages regarding speed of change with early qualitative research showing that customers were reluctant to spend more to increase the speed of change, while quantitative research in winter 2022/23 showed that most customers, both household and non-household favoured going beyond the minimum. For those more reluctant customers, carbon emissions are seen as a wider societal problem that everyone needs to work on, rather than something we should prioritise. Future customers are more likely to want to see this prioritised. Customers on our panel are largely positive about our Carbon

Net Zero policy and three quarters of the customer panel felt positively towards it. [39]

Our strategy & core pathway for Net Zero

Our strategy to meet our Net Zero ambitions will be delivered as a programme of work up to 2050, focusing on reducing operational emissions with our base expenditure, and reducing embedded emissions with our enhancement expenditure. The delivery profile of these enhancement investments is shown in Table 19.

Allowance	Business Case Area / Investment Area	2025 - 2030 costs	2030 - 2035 costs	2035 - 2040 costs	2040 - 2045 costs	2045 - 2050 costs	Timing
Net Zero Enhancement	Fleet	**£4.302m**	**£2.139m**	**£2.139m**	**£2.139m**	**£2.139m**	*2025 - 2050*
	Construction Core Pathway scenario (Capex costs)	**-**	**£4.343m**	-	-	-	*2025 - 2030*
	Construction Slow technology scenario (Capex costs)	-	**£16.287 m**	**£11.944 m**	**£6.515m**	**£2.172m**	*2030 - 2050*

Table 19: Net Zero delivery profile and enhancement 2025 - 2050

Investment in an electric and low carbon fleet and supporting infrastructure represents a 'low regrets' choice as this aligns to the government's decision to ban new petrol and diesel cars by 2030 and by 2040 for HGVs. We are proposing to invest £2m per AMP into building a low carbon fleet and providing the necessary infrastructure and systems to support this. However, depending on the timing of the roll outs of new low carbon cars, vans and HGVs to the market, our investment might need to be pushed back or brought forwards.

Investing in nature-based solutions and further research to understand the carbon benefit of these is required to keep options open to manage residual emissions. Without this understanding the company may become limited to using offsets which deliver less benefit to customer and increase costs. We will work with other companies as part of UKWIR research projects and look to build partnerships with academic institutions, alongside investing in trial projects to build our knowledge base.

Due to the nature of the changing technology landscape, our response is driven by flexibility and the response of other sectors such as the Energy sector. Although our overall approach is unlikely to change significantly, it may need to adapt given different technology options and availability e.g. hydrogen and battery storage.

Our enhancement expenditure from 2030 onwards in low carbon construction materials and techniques will enable us to implement new and emerging innovations when building infrastructure. We will use the 2025 to 2030 period to focus on embedding the principles of PAS 2080, aiming to deliver around 12% reduction in carbon associated with our capital programme before requiring enhancement investment to deliver more stretching reductions only, achievable using low carbon materials and technologies that are more expensive than traditional options.

As our response to Net Zero is driven by the development of technology and the response of other sectors, our approach should remain flexible recognising that our overall approach is unlikely to change significantly but the timing of when we implement action could be more critical. As these technologies become more established within the industry, we hope to adopt them as business as usual.

We have sequenced our enhancement investments to ensure we have the time to upskill our workforce where needed to use Net Zero technologies. Also, many Net Zero technologies such as hydrogen HGVs are nascent, so

[39] AFW04 - What Customers & Stakeholders Want V6

we have assumed that they will not be ready for investment until future AMPs.

Beyond 2050, investment into Net Zero will need to continue to ensure Net Zero is maintained and improved upon. Improvements could include further reduction of emissions in preference to removal (delivered through insetting and offsetting), as per the carbon management hierarchy, requiring continued investment in emerging and innovative construction. This will focus on moving away from reliance on offsets, further reducing any remaining emissions, including those occurring through our supply chain.

Technical optioneering and cost development

A limited series of options are available to deliver our Net Zero Ambition. Many of the activities to reduce operational emissions are funded from base and fall outside of the remit of the LTDS. The only identified relevant activities are the transition to an EV fleet and the benefits derived from the WINEP programme. In the context of the LTDS, optioneering was completed for the EV business case for the period between 2025 and 2030. EV investment within the LTDS period after 2025 - 2030 includes a flat rate to cover replacements and upgrades to charging infrastructure and the transition of more challenging vehicles such as HGVs.

Additional benefits from core pathway for future scenarios

Our core pathway focuses on the timing of action and balances the risks of taking no action (baseline) which increases the risks of not delivering our commitment to Net Zero with increasing investment early which ultimately proves to not offer good value for money.

Not taking action has the potential to cause a negative environmental and social impacts over the timescales of the LTDS, whilst accelerating and increasing investment may not offer customers good value for money.

Core pathway activities to safeguard future options

As our core pathway focuses on the timing of action, we are safeguarding future options by not committing significant investment in areas where technology or best practice is lacking in maturity. This is particularly relevant to construction activities where low carbon construction remains innovative and more expensive.

Alternative pathways for Net Zero

A slower technology scenario has been determined as sufficiently material to require an alternative pathway. Within our alternative pathway, we will be seeking to spend larger amounts of investment from 2030 onwards, where we have identified that the best value plan is not prevailing because of the pace of technology not following the anticipated pace and scale.

The Decision point, Trigger point and Point in which the pathway deviates for the alternative pathway in the technology scenario can be found in Table 20.

Decision point	2030 - We will need to take a decision towards the end of AMP 8 as to whether we continue to follow our core or alternative pathway.
Trigger point	2030 - We will need to follow our alternative pathway if we identify that delivering low carbon infrastructure from AMP 9 onwards is likely to cost more than the planned 1% allowance.
Point at which the pathway deviates	2030 - Our pathways deviate from AMP 9 onwards where the levels of spend increase in a low-tech scenario to achieve the same outcomes.

Table 20: Decision point, Trigger point and Point at which the pathway deviates for the alternative pathway in the technology scenario

Rationale of Net Zero

Identification of core and alternative pathways

We considered three different options in relation to our Net Zero strategy and realising our ambitions of Net Zero operational emissions by 2030 and Net Zero emissions by 2045.

The output of our optioneering is found in Table 21.

Option #	Category	Description	Decision	Reason for Decision
1	Baseline	Maintain base investment in our asset portfolio and fleet. This would result in some emissions reductions as grid electricity decarbonises and low carbon materials and solutions become more common place, becoming available at the same cost as traditional solutions.	Baseline (Do nothing or maintain) - rejected	Likely to have negative environmental and social impacts over the timescales of the LTDS in comparison to alternative options. The do-nothing scenario delays emissions reductions
2	Best Value	Enhancement investment in low carbon fleet and assets, energy solutions and nature-based solutions allow us to respond to emerging technology and changing markets.	Preferred Option /Core Pathway - Adopted	This option has positive environmental and social impacts through reductions in emissions and investment in nature-based solutions.
3	Highest cost	Increased enhancement investment would accelerate delivery of low carbon fleet, trial and implement low carbon technologies and materials and invest in emerging energy technologies.	Acceleration	This option has the potential for greatest environmental and social benefits; however, the option also requires significant investments and carries significant risks. It is not considered to offer good value for money.

Table 21: Summary of the potential options considered for our Net Zero Long-Term Delivery Strategy

Ultimately, the base option and accelerated option were disregarded as they either risk us being unable to meet public commitment and legislative targets or risk spending unnecessary expenditure and passing this on to the customer.

Our core pathway represents the best value option and is based on a prevailing fast technology scenario. With technology influencing out Net-Zero pathway most significantly we have developed an alternative scenario which aims to deliver the same outcomes as our core pathway but under a slow technology scenario. In a slow technology scenario delivering low-carbon infrastructure will cost more than in the core pathway.

Foundations of Net Zero

Assumptions

The core pathway is based on the plans and recommendations made in the UK Government's Net Zero: Build Back Greener Strategy[40] (October 2021) and the Sixth Carbon Budget[41] (December 2020) produced by the Committee on Climate Change. These are based on their own set of assumptions which are set out in each of the documents.

In relation to these, we have made three assumptions for our Net Zero strategy. We assume that our suppliers can provide low carbon solutions for capital projects at the same pace as the UK needs to decarbonise. This will affect our embedded carbon emissions, and if suppliers are not decarbonising quickly enough, we will need to change suppliers. We have also assumed that we will no longer require a green tariff from 2035 onwards, as the UK electricity market has decarbonised. If this is not the case, we might have to increase our investment to invest more in renewable energy. Finally, we have assumed that we can robustly and accurately account for the carbon benefits of our environmental projects which will contribute journey to Net Zero (i.e. river restoration). This will be vital to demonstrate our progress to reaching Net Zero by 2045.

Performance improvements from base expenditure

Over the long term, we expect Net Zero to be achieved through base costs as a core requirement of our activities. Base costs will also include investment towards low carbon alternative technologies such as EV fleets and low carbon construction material, with our Net Zero enhancement pathway including addition investment for where this cost is more than conventional technologies. Base expenditure will also include improvement

[40] Net Zero: Build Back Greener (2021). Available at: https://www.gov.uk/government/publications/net-zero-strategy

[41] Sixth Carbon Budget (2020). Available at: https://www.theccc.org.uk/publication/sixth-carbon-budget/

to energy efficiency across the business during the 25-year period, reducing our total electricity consumption and therefore reducing our emissions.

Uncertainties

Uncertainty in our ability to meet our Net Zero ambition mostly concerns the developments around green technologies and low carbon solutions. If grid decarbonisation does not take place and new green technologies do not emerge then we will need to increase investment into renewable energy to a greater degree than we had planned for. This is also likely to impact our ability to reduce our supply chain activities emissions; without these new technologies, our suppliers will also struggle to reduce emissions.

Uncertainties that cannot meaningfully be alleviated

Another key uncertainty is the impact of changes to legislation including updates to the Carbon Budget. A new budget could increase the depth and rate of decarbonisation required, resulting in an acceleration of our plan.

Whilst we have included the opportunities to test and trial new technologies within our pathway, we are unable to alleviate the uncertainty of the rate at which new vehicle and construction technologies come to market which influence the timing and costs of emissions reductions.

3. Lead

Our ambition for enabling a 'lead-free society'
Our ambition is to exceed regulations, aiming to remove all lead pipes from our 11 highest risk zones (about 76,000 pipes) by 2050, aligning with DWI's lead-free society ambition. Lead, a toxic metal, poses health risks to consumers even very low concentration and drinking water quality regulations have progressively lowered acceptable limits (from 50µg/l in 1998 to 10µg/l presently, with further reduction to 5 µg/l in the future).

Orthophosphoric acid dosing has been used to mitigate lead concentrations at consumer taps since the early 2000s, but its use is unsustainable and costly. The price of this chemical surged 89% between Q4 2021 and Q4 2022, with trends predicted to continue. Strategic full lead pipe removal will eliminate reliance on dosing in the long-term.

Since 2000, around 68,200 communication pipes (CP) have been replaced (18% of the 2000 total). The remaining communication and supply pipes (SP), about 312,000 in our area, comprise the bulk of lead in the network and would cost around £1.3bn at current unit costs to remove fully.

What our customers and stakeholders say
Out of the five key investment areas (reducing abstraction/environmental restoration, Carbon Net Zero, improving resilience, lead replacement, and hard water) lead replacement ranked as the highest priority for customers in a representative study. Just over half were aware that there are lead pipes in the Affinity area and most of those had either checked for them or had them removed. 48% of participants in the study opted for the highest possible level of investment when allocating spend to the different investment areas[42]. This insight conflicts with previous research, which showed a much lower level of awareness and concern, this could be due to the previous survey being qualitative and not representative[43].

[42] Report 207- Customer Priorities for Long Term Ambitions – Quant report, Eftec, 16/11/22

[43] Report 125 - Lead Pipe Replacement 1 Customer research Stage 1 interim report, Blue Marble 10/06/21

In setting our ambition for this area, we evaluated five different options of varying speed of delivery towards achieving a lead-free society. These options ranged from continuing our baseline approach and replacing lead pipes at a relatively small volume, to proactive replacement programmes across the company area. The options are shown in Table 22.

Option	Description	Indicative cost	Commentary
1	**Do minimum** - replace CP & SP at >5µg/l in 2025 - 2030, after that replace ***communication pipes only*** and only at ***>10µg/l***	£7.135m	Insufficient to support our lead-free ambition and satisfy our customers. Addressing the lead risk at a very small number of properties – approximately 250 per AMP, post-2030(0.08% of the total number). Leaving SP to be removed later. Cease to provide enhanced protection to customers post-2030 for concentrations between 5-10µg/l.
2	**Core pathway** - replace CP & SP at properties >5µg/l in 2025 - 2030, after that proactive programme to replace CP&SP in ***11 high risk zones***	£305.323 m	Reactive pipe replacements where samples >5µg/l, large programme of proactive pipe replacement across the 11 high-risk zones. This is best balance of cost, ambition and feasibility to deliver, and supports our long-term ambition.
3	**Least cost** - replace CP & SP at properties >5µg/l in 2025 - 2030, after that replace ***communication pipes only*** at ***>5µg/l***	£11.407m	Insufficient to support our lead-free ambition and satisfy our customers. Partially addressing lead risk, by only removing CPs, and at a very small number of properties – approximately 750 per AMP (0.2% of the total number). We would be leaving the SPs to be removed later.
4	**Mid-point cost** - replace CP & SP at properties >5µg/l in 2025 - 2030, after that ***replace CP & SP*** at properties ***>5µg/l***	£15.807m	Insufficient to support our lead-free ambition and satisfy our customers. Addressing lead risk fully in each property, but at a very small number – approximately 750 per AMP (0.2% of the total number). At this rate it will take more than 400 years to remove lead at all the properties in our company areal.
5	**Highest cost** - replace CP & SP at properties >5µg/l in 2025 - 2030, after that proactive programme to replace CP&SP across ***whole Company area***	£1,127.779m	While Option 5 was the most ambitious, this was not the most cost-effective option for our customers. In addition, there were significant deliverability challenges to overcome to proactively replace all lead pipes across our network within this timeframe.

Table 22: Summary of the options considered for our Lead Long-Term Delivery Strategy

Our strategy & core pathway for enabling a 'lead-free society'
Our proactive strategy to remove lead from properties in our 11 high risk zones will be delivered as a programme of work across a 20-year period from 2030 to 2050. This will be delivered alongside two programmes of reactive work:

- Replacing communication pipes at properties where sample results exceed 10µg/l and offering to replace the supply pipe. We forecast this base expenditure activity will average around 50 properties per year (250 per AMP) based on the historic rate of samples measured over 10µg/l and including a margin for error.

- Replacing communication pipes at properties where results are 5-10µg/l and offering to replace the supply pipe. We forecast this enhancement expenditure activity will average around 100 properties per year (500 per AMP) based on the historic rate of samples measured between 10 and 5µg/l and including a margin for error.

The delivery profile for all three enhancement programs of work is shown in Table 23.

	2025 - 2030	2030 - 2035	2035 - 2040	2040 - 2045	2045 - 2050
Enhancement – Innovation trial (£m)	2.000	-	-	-	-
Enhancement – proactive (£m)	-	31.323	59.276	86.958	115.943
Enhancement – reactive for 5-10µg/l (£m)	2.000	2.060	1.949	1.907	1.907
Spend (£m)	**4.000**	**33.383**	**61.225**	**88.864**	**117.850**

Table 23: Lead pipe replacement delivery profile base and enhancement 2025 - 2030

During 2025 - 2030, we will conduct research into innovative techniques to identify or replace lead pipe which have challenging lead pipe installations, or novel ways of delivering pipe replacements within customer properties. We have estimated the number of pipes to be replaced as part of this trial at 500, although the number may vary depending on the unit cost of the replacements.

There will be no short to medium term meaningful effect on the Compliance Risk Index (CRI) score as a result of lead replacement programme, as the contribution to CRI score from each compliance failure is negligible with our current orthophosphoric dosing strategy, and we can usually demonstrate that the risk was limited to a single property[44].

Our core pathway to achieve our lead ambition is 'low regrets', as it is required across all plausible scenarios. Our strategy remains unchanged when tested against the common reference scenarios and when considering other plausible uncertainties. Cost benefit analysis has determined the potential environmental and health benefits that would be realised as a result of replacing lead communication and supply pipes to be marginally cost beneficial at current unit costs. With innovation and continuous improvement in delivery, a reduction in unit cost will further strengthen the cost benefit for customers During 2025 - 2030, we will identify and test emerging technologies and approaches, collaborating the other organisations and leveraging investment routes such as the Ofwat innovation fund. The intent of this work will be to discover more efficient, less disruptive and/or more deliverable approaches. This will ensure we are well positioned to undertake a significant renewal programme commencing between 2030 - 2035, delivering at a lower overall cost over the 25-year period. The cost profile for the proactive and reactive supply and communication pipe enhancement replacement is shown Table 24.

	2025 - 2030	2030 - 2035	2035 - 2040	2040 - 2045	2045 - 2050
Enhancement – innovation trial	500 pipes*	-	-	-	-
Enhancement – proactive	-	7,600 pipes	15,200 pipes	22,800 pipes	30,400 pipes
Enhancement – reactive for 5-10µg/l	500 pipes	500 pipes	500 pipes	500 pipes	500 pipes
Base – reactive above 10µg/l	250 pipes	250 pipes	250 pipes	250 pipes	250 pipes

Table 24: Lead pipe enhancement replacement costs (2025 - 2050)

[44] https://dwi-content.s3.eu-west-2.amazonaws.com/wp-content/uploads/2020/11/03105604/DWI-Compliance-Risk-Index-CRI.pdf

Looking ahead, we estimate around 240,000 pipes will remain after 2050, constituting 75% of the current total of lead pipes. To ensure their timely replacement, we must develop efficient and affordable full-pipe replacement techniques and methods from 2025 to 2050.

Changes to legislation, such as supply pipe ownership and statutory access to pipes will need to be a significant part of this development. Additionally, the eventual discontinuation of orthophosphoric acid, used to prevent lead-related risks to customers, will require complete removal of lead from the network.

Our scenario testing against Ofwat reference scenarios showed no material impact that would necessitate an alternative pathway. We are confident that our core pathway is sufficiently resilient against various futures.

Rationale of our strategy for a 'lead-free society'

Identification of core and alternative pathways

Having established our ambition to remove lead supply and communication pipes at all properties in our 11 highest risk zones by 2050, we tested a number of delivery scenarios to establish which is the most cost-beneficial for our customers. The scenarios are as follows:

While the 'slow delivery' alternative pathway results in a lower overall capital cost, the significant increase in the number of replacements in the later investment periods results in a significantly increased deliverability risk.

Foundations of our strategy for a 'lead-free society'

Assumptions

We estimated the total number of lead pipes in our network by subtracting the annual replacements from the 2018 baseline data of lead pipes obtained from our Asset Inventory. We also factored in pipes replaced as part of the lead replacement program. For our 11 highest-risk zones, we relied on Affinity Water property counts, assuming a 22% lead presence based on prior findings.

Given the specific goal of lead pipe replacements, our options are limited. Optioneering instead focuses on the phasing of activity under specific assumptions on future efficiency gains through technology. This phasing is considered within section **Identification of core and alternative pathways.** Sensitivity testing of the technology improvements is also included.

Additional benefits from core pathway for future scenarios

By continuing to remove lead pipes, we are improving our resilience to limited supplies of orthophosphoric acid over the long term and readiness to comply with lower prescribed concentration values should DWI reduce this further to aligning with the EU Drinking Water Directive proposal.

Costs for supply and communication pipe replacements were determined using data from 2015 - 2025 with an assumed efficiency adjustment of 1.1% per year for the first 15 years (2025 to 2040). Beyond this period, we anticipate more challenging replacements, so unit costs are held constant.

We will continue to take action if tap water samples exceed our 5 µg/l internal target, assuming the regulatory limit will not drop below this level over 25 years. To ensure lead concentrations stay below 5 µg/l, simply replacing communication pipes is not enough; more of the pipe must be removed.

We won't rely on lining solutions in the short- to medium-term, as directed by DWI. We assume ortho-dosing cannot be turned off in water supply zones until all lead pipes are removed.

We're exploring various programs and mechanisms, like integrating lead pipe replacements into mains renewals or metering programs, to improve efficiency and reduce costs. These efficiency gains are factored into the 1.1% annual frontier shift in pipe replacement costs.

Performance improvements from base expenditure

Negligible progress towards our ambition will be achieved through base activities only, as we forecast that these replacements will average 50 customer properties per year and removal of the communication pipe only. At this rate, it would take around 500 years to remove all the lead in our 11 highest risk zones. Improvements to technology or deliverability would not change this outcome.

Uncertainties

While we will offer all customers the opportunity to remove their supply pipes, we do not expect 100% take up of this offer based on the results of our trials between 2020 and 2025.

- Phase 1 (where we offered free supply pipe replacement) there was take-up of the offer at approximately 85% of the eligible properties; of those, 96% (24 customers) opted for renewal from stop tap all the way to internal stop valve, only 4% (one customer) opted for replacement up to point of entry.
- Phase 2, where customers were asked to pay between £883 and £1,873 for the supply pipe renewal (depending on length and whether replacement was to point of entry or internal stop value), take-up was very low at around 2% of the eligible properties, all of whom opted for replacement to internal stop valve.
- From discussions with Essex and Suffolk Water, we understand that the take-up rate on their trials was approximately 25%, for a similar level of service to us.

Estimating uptake by customers in future AMPs is uncertain. For every property where we are not granted permission to remove the lead supply pipes, we will be leaving lead in the ground for removal later.

An increase in public awareness of the health impact of lead pipes could affect customers' priorities for the pace of lead pipe removal.

There is a financial value attributed to each property where lead is removed, based on the health benefits to occupants. This number is fixed per property, so if the unit cost to deliver the removal can be reduced, then the cost-benefit ratio will improve and could drive quicker delivery of the programme. This has been sensitivity tested within our economic assessment.

Focusing on high-population housing (shared supplies or housing blocks) maximises benefits (reduced lead exposure) for the same cost. Uncertainty exists over potential regulatory changes regarding lead pipes such as lower drinking water concentration values or water company requirements to change customer-side pipe materials. This uncertainty may alter investment needs and effectiveness. Nevertheless, our 2025-30 investment remains valuable, but more regulatory engagement is necessary for post-2030 investments to ensure they remain sensible.

Uncertainties that cannot meaningful be alleviated

Due to the modular nature of our delivery plan, our lead strategy can be sufficiently adaptive to alleviate these uncertainties through the five-year investment cycle.

4. WRMP

Our ambition for WRMP

Every five years water companies are required to produce statutory Water Resource Management Plans (WRMPs) that set out the strategy for ensuring the long-term balance between supply and demand is maintained.

For the upcoming publication in 2024, these plans will be supported by regional water resource plans produced by regional water groups, principally Water Resource South-East (WRSE) and Water Resource East (WRE) for Affinity Water.

Our ambition for our Water Resource Management Plan (WRMP) involves four key objectives:

Leave the environment in a sustainable and measurably improved state. The EA's ambitions regarding reducing unsustainable abstraction are at the core of the WRMP. Both stakeholders and customers support the ambition.

Deliver what our customers need, ensuring affordability for all. We have developed a plan that meets best value (as required through the Water Resources Planning Guidance (WRPG)[45]) while meeting the supply demand balance. We have tested our plans with customers and continue to do so to balance the pace of delivery with the cost of the plan.

Work with our communities to create value for the local economy and society. As part of developing schemes within our plan we assess the impact on society and the environment as part of their development (SEA, HRA and WFD assessments). We have also worked with customers to understand, for the larger strategic schemes, the types of community, social and environmental benefit such schemes could provide and the value they place on them.

Be prepared for change and resilient to shocks and stresses. The process of creating a WRMP looks at the predicted 'future' in terms of population growth and climate change and the resources required to ensure our customers can turn on their taps each day. We have taken an adaptive planning approach to ensure we account for all possible futures and have set out a monitoring approach to assure we flex and change to meet those future challenges.

What our customers and stakeholders say
Providing a safe, secure supply of water is a top priority across all our customer segments and particularly noted by non-household customers. Customers do not instinctively link wider resilience to that top priority but when we dig deeper with them there is an overarching assumption that we plan ahead.

Our customers use a lot of water (currently on average 169 l/h/d) with no real understanding of how much, and no conviction that they really need to use less (AFW04). When exploring options regarding how to reduce demand, customers are generally positive when it comes to increased metering as they believe it is fair to pay for what you use (. Changing behaviours appears difficult and current views from customers on leakage excuse poor behaviour from those who don't want to change, and disheartens those who do (. Hygiene is more important than water saving in customers' minds so the importance of communicating the best habits is key[46]

Customers are concerned about leaks and expect us to be dealing with those before handing any increased costs on to them for additional supplies – it is an area that is regularly mentioned in the research or engagement we undertake and consistently features in the top quarter of priorities.

Our customers expect us to be dealing with leaks before handing any increased costs onto them for additional supplies due to water scarcity. There is an expectation that we will protect our customers from the cost of internal leaks and protect the environment from the impact of the wasted water. Those who care strongly about the environment are most likely to be concerned with external leaks. Leaks are also a popular reason for contact from customers and there is evidence that those who do contact us about a leak are generally more dissatisfied with our service in comparison to other areas.

[45] Water Resources Planning Guidance (2023). Available from: https://www.gov.uk/government/publications/water-resources-planning-guideline/water-resources-planning-guideline

[46] Appendix AFW04 What Customers and Stakeholders Want

In terms of supply options, more reservoirs are largely positively received, due to familiarity. Other sources do raise some concerns. People rarely think about the source of their water, beyond 'underground' or 'reservoir' - knowledge of different sources is low, particularly those not currently in common use, such as desalination and water transfers.

Water recycling has so far received a largely negative reaction, due to safety concerns provoking an instinctive 'yuck' reaction. However, research on the Grand Union Canal (GUC) for the WRMP showed that this particular recycling scheme is viewed favourably even though it includes both water recycling and transfer, because it is seen as 'green' with potential for enhanced public value and use of existing infrastructure. Desalination and water transfer are seen as complex, and there is feeling that such large infrastructure water projects should be a last resort. Desalination carries environmental concerns over the perceived intensity of processing and impact on coastal biomes. Water Community members found recycling had a more positive appeal, especially if their fears around quality and contamination could be allayed with information, or even plant tours[47].

Our strategy and core pathway for WRMP
Our strategy for WRMP will be delivered across the next 5 AMPs, with a Totex value of approximately £3 billion. As shown in Table 25, this enhancement expenditure will be delivered through multi- AMP programmes of supply-side improvements, strategic regional water resources, demand side improvements, leakage improvements, internal interconnectors, new meters for existing customers and replacement of existing meters with smart meters.

Enhancement activity (Water enhancement expenditure by purpose totex)	2025 -30 (£m)	2030 -35 (£m)	2035 -40 (£m)	2040 -45 (£m)	2045 -50 (£m)
Supply-side improvements	60.138	64.809	67.092	67.726	2.268
New meters requested by existing customers (optants)	1.527	1.778	1.794	0.249	0.249
New meters introduced by companies for existing customers	27.480	31.996	32.306	4.481	4.481
Replacement of existing basic meters with AMI meters for residential customers	62.593	72.881	73.585	10.206	10.206
Replacement of existing AMR meters with AMI meters for residential customers	53.433	62.215	62.817	8.712	8.712
Replacement of existing basic meters with AMI meters for business customers	7.633	8.888	8.974	1.245	1.245
Interconnectors	67.148	83.366	3.603	65.765	6.295

Table 25 - Enhancement expenditure (to 3 decimal places)

We aim to leave the environment in a sustainable and measurably improved state through our commitment to reducing abstraction of water from groundwater sources, replacing lost Deployable Output (DO) with alternative sources, as well as our commitment to meet operational Net Zero by 2030 and Carbon Net Zero by 2050.

[47] Appendix AFW04 What Customers and Stakeholders Want

We will deliver what our customers need, affordably, through our best value planning process, which balances cost, resilience, environmental impact, and customer preference to deliver a strategy that provides benefits for customers now and in the future. We will also work with our communities to create value for the local economy and society, further providing benefits for customers, now and in the future.

Our strategy ensures we are prepared for change and resilient to shocks and stresses. Through the regional planning process, WRMP has forecast the effects of different climate change, population growth and environmental abstraction futures to develop a 'no/low regrets' plan that can adapt to meet every reasonable outcome without introducing inefficiency of expenditure. Through regular reassessment of WRMP targets and a sophisticated monitoring plan we can be flexible to meet future challenges.

We have generated investment plans for different scenarios and futures through a regional investment model, working with partner water companies.

When planning adaptively we start off with a feasible, but very low need future with low growth, low climate change impact and lower levels of abstraction reductions. We refer to this as the core pathway and the results from the model are shown in Figure 10 below.

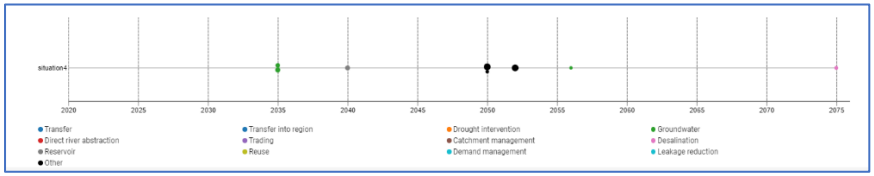


Figure 10: Modelled WRMP lowest need pathway

Under low growth and low Environmental Destination there is no requirement for a large strategic scheme until 2050, when the South-East Strategic Reservoir Option (SESRO) and the Thames to Affinity Transfer (T2AT) are commissioned. The 'least cost' model selects three smaller schemes to meet demand over the 2030 to 2040 period:

SCHEME	Deployable Output	CAPEX	OPEX (per annum)
Egham LGS	5Ml/d	3,686,340	66,161
Epping ASR	8Ml/d	35,127,428.	291,057
Brent Reservoir	7.5Ml/d	30,204,677	164,721

Table 27: Least cost model

Together, these schemes cost £69m for 20.5Ml/d. This is a very high-risk strategy for customers for the following reasons:

- **For the Epping scheme**, Aquifer Storage and Recovery (ASR) potential is entirely unproven at this stage and there are no ASR schemes within this part of the Greensand aquifer to draw parallels against. ASR has not been successful at most Greensand sites, with the exception of recent Thames schemes in the relatively small south London aquifer. This scheme also contains risks under the Water Framework Directive assessment relating to water quality impacts on the chalk aquifer and would likely require significant pre-treatment before storage to mitigate that risk (which is unknown at this stage and hence not included in the scheme design or costings).
- **For the Egham scheme**, the Lower Greensand yields are proving lower than expected in recent testing carried out for the Canal & River Trust (CRT) borehole scheme (selected post 2055 in the programme above), in the order of half our expectations. There is also no reliable information on water quality in this area, and additional treatment beyond the existing Egham treatment works has not been included in the costs.
- The EA has specifically raised concerns associated with the **Brent Reservoir** during the WRMP24 consultation process. The scheme uses the existing Canal and Rivers Trust reservoir in Brent, and our

investigations between 2020 and 2025 confirm the EA concerns that there are almost certainly contaminated sediments within the reservoir. The WFD assessment also concluded that there are risks due to water quality, which means treatment and reservoir dredging is likely to be required before discharge to the canal, and hydrology, which could require compensation flow to mitigate and hence significantly reduce the yield of the scheme.

As we cannot quantify the above risks at this stage, we have not included them in the costs or DO for the investment modelling, but overall, for the schemes listed above, there is a high risk that the costs could be more than double the stated values, whilst the DO could be half the stated values.

These risks mean that the costs and benefits for the four schemes could be as high as £140m and as low as 9-10Ml/d respectively. This would generate an Average Incremental Cost (AIC) of over 200p/m^3 and would result in a supply-demand imbalance, even under the core scenario.

We therefore propose that the core pathway should include the GUC scheme in preference to the three schemes listed above. The risks associated with the GUC are well known and costs contain the appropriate optimism bias. Even with that bias the AIC is in the order of 115p/m3. The investment modelling under the core pathway indicates that only 50Ml/d of the GUC may be required, but this rises to 100Ml/d under the higher growth scenario. Modelling carried out for the rdWRMP also shows that the larger scheme is required to mitigate the risk of customer demand not reducing in line with the targets contained in the Environmental Improvement Plan. Although the GUC transfer could be delivered on a modular basis, the increased output would be required by 2035, and given the lead time this means the decision will need to be made near the start of AMP8 (prior to RAPID Gate 4) as to the preferred size. Following the 'least regrets' investment modelling contained in the rdWRMP we have concluded that we should seek to construct the 100Ml/d version of the GUC transfer under the 'best value' plan, unless there is compelling evidence that this is not required by the 2027 point, or that it is not feasible to deliver the scheme at that scale.

The core pathway has adaptive futures branching off from 2025 (Technology), 2030 (Growth/Demand) and 2035 (Climate Change, Environmental Destination). For the pathway to maintain a status of 'no regrets', any investment before these branch points needs to encompass enabling works that allow for the development of future options. Therefore, in between 2025 and 2035, appropriate planning will be necessary for development and construction expenditure for both the GUC and SESRO. Without this expenditure, it is likely that during the branch points of 2030 and 2035, if we face a more adverse situation than the core pathway, we could face a supply-demand deficit.

Through the four common reference scenarios, we have identified the investment that is required prior to the deviation of each common reference scenario to meet the most adverse future scenarios, while remaining cost effective for a 'no/low regrets' plan. Regardless of future scenarios, investment in large scale SROs planning and development phases is a necessity to minimise future costs of options, should an adverse scenario occur.

Investments have been sequenced to meet the requirements of the LTDS guidance throughout each AMP. For example, from 2025 to 2030 we will be focusing on demand management strategies (including metering and leakage) to meet the technology pathway associated with the core pathway. This should result in earlier demand savings benefits. Other investment in this AMP is driven by the development of Strategic Resource Options (SROs) to ensure future development of options to meet the possibility of adverse scenarios.

For the Long-Term Delivery Strategy's core pathway, a 'no/low regrets' investment initiative has been adopted. Through this method, Affinity Water would focus early investment on Demand Management Strategies and delay the construction of large infrastructure projects as they are usually the most economically beneficial options to adopt. However, a 'no/low

regrets' strategy still ensures that investment necessary to allow the implementation of more expensive options is still included within the plan, to allow for the development of these larger options in the case of a more adverse future than predicted.

Between 2030 and 2035, our investment will cover the construction cost of the GUC transfer (50Ml/d under least cost core pathway, 100Ml/d under the best value plan) and planning and development costs for SESRO. High demand management strategy costs will also remain in accordance with LTDS guidance on the core pathway. Between 2035 and 2040, we will still be investing in the planning and development costs from 2025 to 2035. Depending on the adaptive pathway adopted, we will invest in construction of SESRO at the end of the AMP. The expenditure on these drivers is required to keep the availability of options in the long-term plan open. Between 2040 and 2050, we will invest in the maintenance of leakage and metering, and development of operational costs for supply schemes. By 2039/40, we will have reached the trigger point for all common reference scenarios and the pathway will dictate future expenditure.

Looking ahead, the impact of climate change on available DO is forecast to increase beyond 2050. Our regional modelling continues out to 2075, therefore any further investment required post-2050 is incorporated into our strategy, and investment necessary to address this pressure is incorporated in our LTDS. As our strategy progresses, the benefits from demand management begin to plateau, but population continues to grow, creating a greater overall demand. Similar to climate change, this increase in population is included in our regional modelling and accounted for as part of our strategy.

Decision Point	2028 (and 2025 – see above)
Trigger Point	2033
Point in which the pathway deviates	2033

Table 28: Decision; Trigger & Deviation Points - Demand scenario

Additional benefits from core pathway for future scenarios

Early enhancement expenditure between 2025 and 2030 on SROs provides the opportunity to develop options with significant Deployable Output benefit. The primary investment is in three options: Abingdon Reservoir (SESRO), Grand Union Canal (GUC) and Thames to Affinity Transfer (T2AT).

T2AT in particular provides flexibility in the planning process as the option is modular. While we adopt a 50 Ml/d option in 2049/50, there is an opportunity to further develop the option to add an additional 50 Ml/d to provide further water if required, although this is unlikely to be required if we construct the 100Ml/d GUC transfer.

Alternative pathways for WRMP

As we have determined that the GUC transfer should be included as a first strategic scheme in 2032 even under the least cost core pathway, this means we are already able to cover a range of scenarios within our core pathway in the pre-2040 period. This, in turn means there are limited adaptations under most of the Common Reference scenarios. However, our best value proposal contains the 100Ml/d GUC transfer in 2032 and it is important to understand how this best value approach compares to the least cost investment that is generated for the Common Reference scenarios.

The least cost investment plans required under Common Reference scenarios are provided below, both as isolated changes and in-combination effects.

Climate change RCP 2.6 and 8.5 scenario:

Because of the selection of the 50Ml/d GUC transfer even in the least cost core pathway scenario, and the limited impact that climate change has on our existing resources, there are no adaptations required for the higher climate change scenario prior to 2035. The costs shown below show an apparent increase, but that is because the exclude the DPC costs associated with Strategic Regional Options. Because the climate change scenarios assume low growth and low environmental destination, they do

not require the Thames to Affinity Transfer, and utilise smaller options instead, which are constructed in the 2035-2040 period and then used after that point.

	2025 -30 (£m)	2030 -35 (£m)	2035 -40 (£m)	2040 -45 (£m)	2045 -50 (£m)
Additional enhancement activity (Water enhancement expenditure by purpose totex)	-6.800	15.021	70.194	2.299	2.684

Table 29: WRMP additional enhancement expenditure – Climate change scenario

Faster and slower technology scenario:

Because the selection of the GUC transfer in the core pathway provides headroom in the period up to 2040, there are no adaptations required for the slower technology scenario.

4: D

	2025 -30 (£m)	2030 -35 (£m)	2035 -40 (£m)	2040 -45 (£m)	2045 -50 (£m)
Additional enhancement activity (Water enhancement expenditure by purpose totex)	-30.608	-120.213	166.113	110.883	5.240

Table 30: WRMP additional enhancement expenditure - Technology scenario

Low and high demand scenario:

Within the least cost modelling the high growth scenario contains the GUC transfer at 50Ml/d in 2032. However, it also includes the three high risk smaller schemes described under the core pathway above within the 2030 to 2040 period. Whilst the least cost modelling therefore incorporates those three schemes as the required adaptation for the LTDS, under our preferred strategy as described in the WRMP, the regional modelling indicates that the construction of the full 100Ml/d GUC scheme presents a better approach. The scheme is £130m more than the 50Ml/d option, so in Capex terms the difference between that and the smaller schemes is only £60m for a much higher rate of certainty in DO, 31Ml/d of additional supply-demand headroom and a much lower AIC. In practice we will look to 'right size' the GUC scheme as the RAPID Gate 3 evaluations progress, so the differential cost and surplus could reduce. The decision over the final size of the GUC transfer (which is expected to be between 75Ml/d and 100Ml/d DO depending on final need and environmental constraints) will need to be made as part of the RAPID gated process, at the end of the EIA scoping phase in Gate 4, in 2025, and will take into account the final WRMP24 and FD24 plans. As the scheme will be DPC this does not affect investment between 2025 and 2030 (the planning costs are the same irrespective of the size of the scheme). As described above, we have determined that the high demand scenario was material enough to design an alternative pathway.

	2025 -30 (£m)	2030 -35 (£m)	2035 -40 (£m)	2040 -45 (£m)	2045 -50 (£m)
Additional enhancement activity (Water enhancement expenditure by purpose totex)	22.232	7.638	2.856	3.896	39.868

Table 31: WRMP additional enhancement expenditure – Demand scenario

Point in time at which the alternative pathway deviates from the core or another alternative pathway	The two pathways will deviate from 2025/26, however, much like the climate change scenario, the difference in pathways is not significant until the later AMPs.
When the decision would need to be taken about whether the alternative pathway is followed (decision point)	The decision point to adopt the alternative pathway is 2029/30. This will provide adequate time to provide investment in the strategy to meet the supply demand deficit by 2035.
Circumstances under which the alternative pathway would need to be followed (trigger point)	If actual population and property figures are greater than that of ONS18 and begin to show signs of aligning with the Housing Plan, the alternative pathway would have to be adopted.
Why the specific alternative pathways and trigger/decision points have been chosen, including why the uncertainty identified	There is approximately a demand increase of 85 Ml/d between the adverse and benign scenarios. This is a significant difference that requires a large investment to mitigate. 85 Ml/d is close to the complete capacity of the

needs to be alleviated through an alternative pathway	T2AT; therefore it is necessary to create an alternative pathway for the high demand scenario.
Why the date(s) associated with the trigger/decision point is important	The decision point in 2029/30, is required to provide significant time for investment to meet the new scenario.

Table 32: Details and rationale of the decision and trigger points for the alternative pathway for the demand scenario

Low and High abstraction reduction scenario:

Because there is little deviation in Environmental Destination targets until 2040, the main impact for this scenario is that the T2AT scheme is brought forward to 2040, replacing the need for the Brent Reservoir re-purposing scheme (when compared to the low growth, low Environmental Destination core pathway) under the least cost plan. Under a Best Value, GUC-led approach, this adaptation is only required if the full 100Mld scheme cannot be delivered (i.e. the T2AT scheme needs to be brought forward if the GUC can only deliver at 50Ml/d).

	2025 -30 (£m)	2030 -35 (£m)	2035 -40 (£m)	2040 -45 (£m)	2045 -50 (£m)
Additional enhancement activity (Water enhancement expenditure by purpose totex)	-12.563	-2.852	0.299	-0.784	65.966

Table 33: WRMP additional enhancement expenditure – Abstraction Reduction scenario

We have determined that the high abstraction reduction scenario was material enough to design an alternative pathway.

Decision Point	2035
Trigger Point	2040
Point in which the pathway deviates	2040

Table 34: Decision; Trigger and Deviation Points – abstraction reduction scenario

Under an in-combination scenario of high growth and high Environmental Destination the GUC 100Ml/d scheme is required in the least cost modelling in the early 2030s, along with the Egham LGS scheme. Both stages of the T2ATscheme are then required in 2050.

Point in time at which the alternative pathway deviates from the core or another alternative pathway	Under the high ambition, there are further abstraction reductions that are not included in the low ambition. This deviation begins in 2039/40
When the decision would need to be taken about whether the alternative pathway is followed (decision point)	Decision is required in 2034/35, to provide enough time for additional investment to meet the supply demand deficit in 2039/40.
Circumstances under which the alternative pathway would need to be followed (trigger point)	Environmental Destination is a policy driven pathway. A decision between the regulators and Affinity would trigger the alternative pathway.
Why the specific alternative pathways and trigger/decision points have been chosen, including why the uncertainty identified needs to be alleviated through an alternative pathway	There is approximately a 100 Ml/d impact on DO between the high and low scenarios. This difference would require a significant investment to mitigate.
Why the date(s) associated with the trigger/decision point is important	The decision point is important as it needs to be made early enough to provide significant time for investment to meet the SDB deficit at the trigger point in 2039/40.

Table 35: Details and rationale of the decision and trigger points for the alternative pathway for the abstraction reduction scenario

WRMP reported pathway:

The WRMP reported pathway deviates from the LTDS core pathway in 2025/26, due to the adoption of a different demand management Strategy. This 'Medium' strategy is a middle point between the fast and slow technology common reference scenarios. This shows a more realistic and cost-effective metering and leakage approach meeting full smart

metering penetration by 2040 and 50% leakage reduction by 2050 allowing for cheaper and more efficient operation of the metering strategy.

There is further deviation from the core plan. In 2030, the pathway adopts H-Plan growth. In 2039/40, the pathway also adopts enhanced Environmental Destination and a climate change scenario comparable to RCP 8.5. The WRMP reported pathway shows a severe scenario with a significant likelihood of occurring. The inclusion of this run in the LTDS demonstrates the necessary investment during 2025 to 2030 that is required to maintain a 'no low regrets plan.

	2025 -30 (£m)	2030 -35 (£m)	2035 -40 (£m)	2040 -45 (£m)	2045 -50 (£m)
Additional enhancement activity (Water enhancement expenditure by purpose totex)	-	-145.366	162.633	11.753	92.009

Table 36: WRMP additional enhancement expenditure – WRMP Reported Pathway scenario

Decision Point	2030
Trigger Point	2030
Point in which the pathway deviates	2030

Table 37: Decision; Trigger & Deviation Points – WRMP reported pathway

Rationale of WRMP

Identification of core and alternative pathways

The requirement for the core pathway is to be developed as a 'no/low regrets' pathway. To adhere to these requirements, the pathway was selected to keep options open in a range of scenarios, including the four common reference scenarios.

The best value pathway was developed in accordance with the WRMP. For the four common reference scenarios, the pathways chosen were representative of the scenarios that characterise the WRSE regional planning. High Environmental Destination, high climate change, medium demand, and intermediate technology. This option was developed to show the expenditure in the 'reported pathway' that Ofwat have set for WRMP.

The WRMP reported pathway (also referred to as the best value plan) is the adopted strategy for WRMP. It is characterised by high growth (H-plan), high climate change (RCP 8.5), enhanced Environmental Destination and a median between fast and slow technology.

Enhancement funding for preparatory work

Our enhancement funding for preparatory work will be needed for our SROs, in order to keep future options open.

The GUC has three development options which are single 50Ml/d, whole 100ML/d or modular 50ML/d plus 50Ml/d. We will require at least 50Ml/d of GUC by 2031.In the core pathway the expenditure to build the whole 100Ml/d option is not necessary under some benign scenarios but is under any adverse scenario that includes high growth or demand management is not achieved, where we are likely to require 100Ml/d by 2040. Therefore, the best value option is to construct the 100Ml/d GUC scheme

As the scheme is built modularly, we can continue to monitor the adaptive pathway and determine later if the additional investment is required. This adaptive approach minimises costs, while keep option available for adverse futures.

The WRMP represents a significantly more adverse situation than the LTDS core pathway, with adverse growth, climate change and environmental abstraction scenarios. This represents a scenario with a greater DO demand than the other modelled pathways in the LTDS, while still having a significant likelihood of occurring. This adaptive pathway has been included to show why the enhancement in early AMPs, on long lead options, is necessary.

Table 38: Summary of the potential options considered for our WRMP Long-Term Delivery Strategy

Option #	Category	Description	Decision	Reason for Decision
1	Baseline	Replacement metering and maintenance leakage	Do nothing or maintain – rejected	This option is Do Nothing, provides no benefit beyond baseline
2	Best Value	GUC 100 (2032) SESRO, T2AT Phase 1 (2052), 2 Smaller (<5Ml/d) Supply Schemes High Demand Management Scenario Internal Interconnectors BVP High Leakage Intervention Strategy High Smart Metering Strategy	Preferred option (Low ED) (High Demand) (Low CC) (Medium Technology) - Chosen	This is mid-range pathway for WRMP. This strategy was developed through the WRSE regional best value planning process. Through this process, environmental impact, societal approval rating and DO benefit is balanced to deliver the most cost-effective plan.
3	Lowest Cost	50Ml/d GUC transfer scheme in 2032 SESRO 75Mm^3 in 2045 T2AT Phase 1 in 2050	Core Pathway (Low ED) (Low Dem – but with GUC to address alternative scheme delivery and environmental risks) (Low CC) (Fast Tech)	This pathway identifies the no/low regret investment required to deliver DO requirements while adhering to the environmental and societal requirements of the Water Resource Planning Guidance.
4	Alternative pathway 1	Same as Core Pathway to 2040 Greater impact on DO Reductions approximately an additional 12.5 Ml/d impact. SESRO 100Mm3 in 2040, but no T2AT scheme	Adverse Climate Change	Same as Core Pathway in short term, with additional consideration for resilience implications from higher CC. No T2AT required due to low growth and inclusion of GUC scheme.
5	Alternative Pathway 2	GUC 50 Ml/d in 2032 Egham LGS in 2033 Epping ASR in 2033 Brent Reservoir in 2035 SESRO 100Mm^3 in 2040 T2AT Phase 1 in 2040 T2AT Phase 2 in 2050	Adverse Demand	Increased investment requirements due to higher growth. High risk of environmental damage and/or cost increases due to the inclusion of the Brent Reservoir and Epping ASR schemes, so we are likely to promote GUC 100Ml/d as per the Best Value Plan which removes reliance on those two options.
6	Alternative Pathway 3	Same as Core Pathway. Low Demand Management Strategy Low Leakage intervention Strategy Low Smart Metering Strategy	Adverse Technology	Same as Core Pathway. Less consideration on social impacts due to nature of slower demand intervention. Demand Management is heavily supported by community slower implementation provides lower societal benefit.
7	Alternative Pathway 4	GUC 50Ml/d in 2032 SESRO 100Mm^3 in 2040 T2AT Phase 1 in 2040 T2AT Phase 2 in 2050	Adverse Abstraction Reduction	Same as Core Pathway. Additional environmental impact consideration due to larger and more numerous supply options which have a greater impact on environment.

Assumptions

We have assumed that there will be approximately 31Ml/d of benefit delivered through government led demand management policies. This is based on a report produced by Sydney University on white goods labelling.

We have also assumed that under a fast technology scenario, rapid implementation of the demand management strategy will yield a similar total benefit and customer response to stimulus will remain constant. This is based on an agreed commonality across WRSE companies.

Our approach to Target Headroom has been updated since WRMP19. Covid-19 allowance has been removed from Target Headroom and included in baseline demand. This accounts for approximately 10 Ml/d of the baseline demand, reducing Target Headroom by approximately 8%.

Performance improvements from base expenditure

Base expenditure in the WRMP incorporates replacement metering and leakage renewal. These expenditures are based on the requirement through the plan to maintain the level of demand saving from smart meters and leakage reduction from the prior year. Any demand savings from these drivers, over the previous year's value, then becomes expenditure as it provides an additional benefit.

Uncertainties

A key uncertainty is the cost of the SROs. All SROs in the WRMP are currently in Gate 3, where the micro component cost of options, land and development costs are further developed. Furthermore, there is relevant uncertainty about the engineering constraints of certain schemes, which will be alleviated through further development of the options. There could be changes to the associated cost of these options after Gate 3 is completed.

We are currently expecting to meet our PCC of 110 l/h/d with intervention from the government as support. However, if this target is missed it will affect our water available for use due to higher demand than was forecasted.

Future energy prices are another key uncertainty, and this is likely to have a significant effect on our operational expenditure. We are currently using uplift factors to predict future operational costs but there is still a level of uncertainty to this.

Additional alternative pathways were developed by the WRSE regional group. These have certain impacts on Affinity Water but are mitigated through the early AMP enhancement expenditure and do not significantly alter the core pathway; individual reference scenarios were not developed to show these.

Uncertainties that cannot meaningfully be alleviated

Due to the adaptive planning approach adopted at WRSE for the modelling process, there are no uncertainties that cannot be alleviated through a 'no low regrets' investment process. The core pathway of the LTDS represents a benign scenario, therefore any investment included in the pathway can be considered necessary under any future. The WRMP reported pathway is close to the most adverse scenario that can reasonably occur. Therefore, through our modelling we have determined the necessary investment to maintain the 'no/low regrets' strategy.

5. Raw water deterioration

Our ambition for raw water deterioration
We are committed to exceeding our customers' water quality expectations, as they trust us to maintain the highest standards. We will continue to meet and reduce our Compliance Risk Index (CRI) targets, further enhancing our industry-leading water quality performance.

The decline in our raw water sources affects our service quality. To maintain excellence and reliability, we will actively manage changes in raw water quality. Our goal is to protect our service and reputation for water quality.

What our customers and stakeholders say
Clean, good tasting water is our customers' top priority. However, customer perceptions are variable, and few customers reach out to complain.

Customers are largely unaware of the processes behind water treatment. Our July 2022 research showed that some were aware of chemicals like chlorine being added, but, beyond that, knowledge was sparse, and some even chose not to know.

We see a mix of views from our customers. High quality water appears to be taken for granted, as it is viewed as a hygiene factor. 33% of customers say they are satisfied with the quality of their water, although perceptions are improving. Analysis suggests this links to wider aesthetic issues such as hardness rather than water quality. Focus groups in Summer 2022 indicated customers trust Affinity to provide safe and clean water (AFW04).

Our strategy and core pathway for raw water deterioration
Our strategy to reduce raw water quality deterioration involves proactive measures within the WINEP program, such as catchment management and engagement with land users. We will take an adaptive approach, investing when water quality deterioration materialises. We prioritise 'green' over 'grey' solutions, aiming for environmental and customer benefits.

We have identified eight potential causes of future raw water quality deterioration, listed in Table 39. Activities listed are ways to mitigate these risks. This list is subject to change and will be updated in future LTDS drafts.

Specific Enhancement Expenditure Activities
Upgrade the treatment processes at surface water treatment works to increase resilience to climate change driven WQ changes on the River Thames
Safeguarding sources from increasing concentrations of nitrate
Safeguarding sources from increasing concentration of contaminants due to plume migration following sustainability reductions
Safeguarding sources from deterioration resulting from 3rd party development activities in Source Protection Zone (SPZ)1
Safeguarding sources from deterioration resulting from 3rd party pollution events
Safeguarding sources from deterioration resulting from drought
Safeguarding sources from deterioration resulting from flooding – pluvial, fluvial and groundwater
Protection of gravel wells and other groundwater sources from saline intrusion

Table 39: Actions we may need to take to respond to potential causes of deterioration

Alongside this enhancement expenditure, our base activities include capital and reactive maintenance to maintain and safeguard the current levels of service and water quality.
When water quality risks arise, we will evaluate core pathway investments using consistent criteria, considering cost, risk, and benefit. We will also assess if these investments support other programmes, such as WRMP, or sustainability reductions to protect chalk streams. Doing this will ensure that investments made are always 'no-regrets'.

Continuous monitoring of raw water quality is vital. We will establish decision points to determine if investments are needed in order to maintain service quality. These points allow us time to assess criteria like cost, risk, and benefit, ensuring proactive risk management and value-driven decisions for current and future customers. The enhancement investments required to safeguard water quality over the 25-year period .

Scheme	2025 - 2030	2030 - 2035	2035 - 2040	2040 - 2045	2045 - 2050
Bowring & Baldock Road (PFAS)	6.972	-	-	-	-
Blackford (PFAS)	10.856	-	-	-	-
Broome (Nitrates)	5.015	-	-	-	-
Egham (Crypto)	15.186	-	-	-	-
Holywell (PFAS)	1.053	-	-	-	-
Iver (Crypto)	46.466	-	-	-	-
Kingsdown (Nitrates)	5.153	-	-	-	-
Wheathampstead (PFAS)	0.491	-	-	-	-
Ardleigh (PFAS)	0.651	-	-	-	-
Stortford (Nitrates)	1.973	-	-	-	-
Slip End (Nitrates)	-	-	11.075	-	-
Bowring (Migration of Contamination)	-	12.921	-	-	-
Wellhead (Migration of Contamination)	-	3.692	-	-	-
Unknown (Third Party Pollution)	-	16.287	16.287	16.287	16.287

Table 40: Enhancement investments required (£m)

We will align investments with emerging raw water quality risks, directly reflecting when these risks become significant. The sequencing of investment for each risk represents the forecast point at which risks will impact the raw water quality of our sites.

Looking beyond 2050, we must proactively manage evolving raw water quality risks in our catchments and sources. Climate change will continue to impact raw water deterioration. We must continually monitor our raw water quality, particularly in reference to climate change, to pinpoint the additional investment that will be required beyond our core pathway.

Technical optioneering and cost development

We considered multiple approaches for each forecast instance of raw water deterioration.

We evaluated two proprietary nitrate removal ion-exchange technologies – ACWA (an ion exchange nitrate removal plant) and IONEX (a nitrate removal technology to remove nitrates from drinking water. Ion exchange is globally regarded as the most efficient and best value technology for this purpose. Our baseline assumption is that all efforts to mitigate the risk through catchment management or green solutions would be explored and exhausted before the grey solution approach was adopted. We discounted blending options as resulting in too great a loss of resilience. We derived our cost estimate data for future nitrate installations from two fully scoped projects within our PR24 business plan and the ongoing delivery of an ion exchange plant between 2020 and 2025. This provides us with a high degree of cost confidence.

Where saline intrusion was the water quality concern, we deemed reverse osmosis to be the only suitable treatment process to address this risk. Other conventional treatment processes are not able to remove ions such as Na+ and Cl-. Our cost estimates for future treatment investments were formulated using our internal cost models, which integrate our own data alongside additional data from Mott MacDonald and industry cost databases.

Where the contaminant of concern was Cr(VI)[48] or unknown (caused by future third party pollution events), we have taken the view that a treatment process such as ion exchange is a suitable approach. It is not possible to carry out a review of best value treatment solutions because the exact contaminants related to future third party pollution are not known. However, ion exchange is in use globally to address contamination from a number of different chemical groups including PFAS[49] and Cr(VI).

[48] hexavalent chromium – a chemical associated with cancer

[49] per- and polyfluoroalkyl substances: artificial chemicals that are used to make many different products, that stay in the environment for a long time and are harmful to the health of people and animals

Additional benefits from core pathway for future scenarios

We will look for all opportunities to implement proactive measures to prevent the deterioration of raw water quality whenever possible. This will be delivered through multiple workstreams within the WINEP programme, including catchment management and positive engagement with land users in our catchment areas. This will provide benefit across all the potential future scenarios.

Moreover, when we step up treatment at a site (beyond just disinfection), we enhance its ability to withstand water quality challenges in the future. Processes like GAC adsorption and ion exchange treatment effectively remove myriad contaminants. Installing such processes allows us to adapt and optimise treatment methods in the future, making us better equipped to mitigate new or emerging contaminants. This resilience extends across all potential future scenarios.

Alternative pathways for raw water deterioration

The following tables show at what point the decision as to whether an alternative pathway will be taken for each scenario, and the point at which this alternative pathway will be followed.

Climate change:

We have determined that the climate change scenario was material enough to design an alternative pathway.

Decision Point	(i) 2030 - sea level rise is sufficiently high that the raw water aquifer from which Kingsdown WTW abstracts is affected, and appropriate treatment at Kingsdown WTW is required in order to continue to supply that water to consumers. (ii) 2040 - storm surge and sea-spray events become sufficiently extreme and frequent to cause deterioration of the gravel well water at Denge, and appropriate treatment at Denge WTW is required in order to continue to supply that water to consumers. (iii) 2030 - climate change driven groundwater level changes are sufficiently extreme that historic nitrate in the soil around North Mymms and Whitehall WTWs is mobilised and causes deterioration of the water quality in those aquifers, and appropriate treatment at North Mymms and Whitehall WTWs is required in order to continue to supply water to consumers from those sites. (iv) 2040 - climate change driven algal blooms and turbidity spikes are sufficiently extreme that the existing treatment processes at Iver and Egham WTW cannot maintain design output, appropriate treatment is required at both sites to continue to supply water to consumers from those sites.
Trigger Point	(i) 2030 - concentration of salt (NaCl) in the water in the aquifer. (ii) 2040 - concentration of salt (NaCl) in the water in the gravel wells. (iii) 2030 - concentration of nitrate in the water in the aquifers. (iv) 2045 – frequency and duration of algal blooms on the River Thames and in raw water storage reservoirs and of turbidity spikes in the River Thames.
Point in which the pathway deviates	(i) 2030 (ii) 2040 (iii) 2030 (iv) 2045

Table 41: Decision Point, Trigger Point and Point in which the pathway deviates for the alternative pathway in the climate change scenario

	2025 -30 (£m)	2030 -35 (£m)	2035 -40 (£m)	2040 -45 (£m)	2045 -50 (£m)
Additional enhancement activity (Water enhancement expenditure by purpose totex)	-	55.919	49.228	33.161	160.687

Table 42: Raw Water Deterioration additional enhancement expenditure – Climate change scenario

Catchment care:
We have determined that the catchment care scenario was material enough to design an alternative pathway.

Decision Point	2045 - When trends on the nitrate concentration in the River Thames indicate that the average and/or peak annual concentrations will increase to such a level that we will no longer be able to manage the water quality risk through blending with alternative supplies alone.
Trigger Point	2050 - This may be triggered by climate change related increases in nitrate concentration in the river and in the stored water that we use for blending (Queensmead Lake and the TWUL reservoirs at Wraysbury) but are more likely to be triggered by changes in farming and land use practices in the Thames River catchment.
Point in which the pathway deviates	2045

Table 43: Decision Point, Trigger Point and Point in which the pathway deviates for the alternative pathway in the catchment care scenario

	2025 -30 (£m)	2030 -35 (£m)	2035 -40 (£m)	2040 -45 (£m)	2045 -50 (£m)
Additional enhancement activity (Water enhancement expenditure by purpose totex)	-	-	-	-	597.190

Table 44: Raw Water Deterioration additional enhancement expenditure – Catchment Care scenario

Core pathway activities to safeguard future options

Continuing with our programme of online and grab sample water quality monitoring for our raw water sources is critical to ensure we have timely and accurate information on which to forecast the timing for delivery of any necessary treatment. We must continue to share this water quality data with key stakeholders, including neighbouring water companies who use the same raw water sources, and third parties such as the EA. We will continue to enable meaningful and productive conversations with partners via groups such as the Thames Catchment Management Steering group.

We will also continue to engage with, and learn from, inter-company research projects, such as those facilitated by UKWIR and Water UK and continue to carry out our own research and development activities to better understand our source waters and the combination of water quality risks we face. We will continue to work with suppliers to identify opportunities to get the best performance from our existing assets and minimise the need for expensive new treatment processes, e.g. with CPL (GAC supplier) to identify optimised carbon for PFAS removal.

Retaining ownership or rights over land at our water treatment works and storage reservoirs is critical. Without land, our ability will be limited to develop the mitigation measures that provide the best value for our customers in the future. When considering the sale of company land, we must account for potential future requirements for water quality protection.

Rationale of raw water deterioration

Identification of core and alternative pathways

We analysed the risks to raw water quality in our supply zones and the potential solutions to resolve them. Our study covered various factors affecting raw water quality, like saline intrusion, climate change, development in source protection zones causing contamination, and sustainability reductions' impact on downstream sources. We quantified long-term risks in Megalitres per day (Ml/d) and provided data on expected concentrations and timelines. Based on these risk factors, we have developed a core pathway to estimate the necessary investments for safeguarding our raw water supply at production sites.

Where water quality risks materialise, we will conduct a comprehensive options assessment, including options to turn off the source and develop an alternative water source for the area as well as blending. For each source or water treatment works, we will evaluate multiple options to make the most cost-effective decision. Once this has been completed, the specific investment requirement will be presented as a business case for review

under the Price Review process for enhancement investment. This approach ensures that the most cost effective and value driven investment decisions are made, to best manage raw water deterioration in the short, medium, and long term. By checking at every stage that the investments are still required based on water quality risk and supply-demand balance need we ensure that the investments will be 'no-regrets'.

Foundations of raw water deterioration

Assumptions

We have assumed one water treatment works per AMP will be affected by third party pollution and construction water quality risks and have used 10Ml/d as a guide when estimating the remediation cost, based on the past incidence of similar events.

We have used a flat rate of £1.5m per Ml on sites when estimating the cost of complex mitigation treatment, based on our experience from the current AMP and PR24 of costing schemes for delivery and outturn costs.

We have assumed that our existing nitrate trend models, based on historic data, are accurate enough to use for forecasting in which AMP sources are likely to breach PCV[50] (or if they are unlikely to). We will continue to review and revise those models as we collect additional data points.

These assumptions have been based on our knowledge of the catchments and geology as well as sample data to assess where we believe sources may be at risk from migration of a contamination plume when a site is turned off for SRs. We have also used publicly available information and modelling about water temperature, atmospheric temperature, rainfall projections and sea level predictions when assessing the potential impact of climate change on our sources.

Performance improvements from base expenditure

No material improvement to our resilience to deteriorating raw water quality will be achieved through base activities. The raw water quality risks identified within this programme are emerging, so are not currently mitigated and therefore not covered by base investment. Measurable benefits from base WINEP activities (catchment management, investigations etc.) are quantified within this programme of work.

Uncertainties

Several uncertainties and opportunities may impact our long-term strategy to manage raw water deterioration. There is a degree of uncertainty on the success of our WINEP catchment management and river health activities. If the planned activities in the programme fail to deliver our forecast outcomes, there may be additional deterioration of raw water quality. Conversely, a successful WINEP programme could improve land use and practises in our catchments, positively affecting water quality and potentially reducing future investment costs.

Uncertainties that cannot meaningfully be alleviated

Climate change rate and effects over the next 25 years introduce uncertainties. Monitoring and modelling the impact on the River Thames and reservoir water quality is crucial. Climate change may increase drought frequency, sea levels, and storm events, affecting raw water quality.

Uncertainty surrounds third-party actions like development and pollution impacting groundwater quality. We must prepare to respond to potential deterioration from these activities near our groundwater sources.

[50] Prescribed Concentration or Value (PCV) limits are legal thresholds for acceptable levels of contamination in Drinking Waters.

6.1 Resilience - water network resilience to climate change

Our ambition for water resilience to climate change

Our water network faces increasing risk from climate change. As a result of climate change, we are seeing more extreme weather events than previously[51]. The link between extreme weather events and mains bursts is well understood, with hot, dry periods or rapid temperature variations (e.g., freeze thaws) causing significant ground movement in clay soils. This movement fractures pipes made from inflexible materials such as cast iron and PVC[52].

Our analysis of the differing climate change scenarios within the plausible range outlined within the Ofwat Common Reference Scenario, indicates that climate change will increase the burst rate in our network by between 57 to 121 bursts per annum by 2050 (see Figure 11). Unmitigated, these bursts will increase the risk of supply interruptions and to water quality and will increase leakage, whilst the additional repairs required will create more disruption for our communities.

We have identified that whilst all rigid materials in clay soil are susceptible to the impact of climate change there is approximately 7% of our network that is highly vulnerable and contributes significantly to the forecasted increase. Despite being amongst our older cohorts, only a small proportion of these mains would be replaced through our usual asset health driven replacement over the period given their comparatively good performance, so we require additional intervention to offset the impact of climate change.

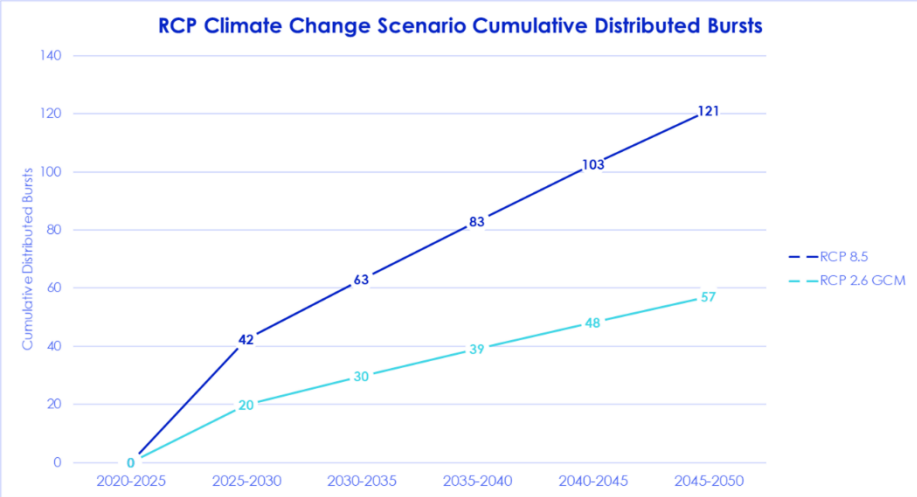


Figure 11: Effect of climate change on mains bursts

What our customers and stakeholders say

Our 'What Customers and Stakeholders Want' report[53] (states: providing a safe, secure supply of water is a top priority across all our customer segments. We have explored the topics of both bursts and leakage extensively with our customers and they have told us that bursts are one of the first areas they identify when they think about resilience. In our priorities engagement across all the insight, we see leakage consistently featuring in the top quarter of priorities. We have reflected this combined leakage and burst priority through our best value approach, finding options that deliver the greatest value, whilst sufficiently offsetting the effects of climate change.

[51] Reference Met Office Report Effects of Climate Change

[52] Reference UKWIR Report Impact of Climate Change on Asset Management planning (Ref No 12/CL/01/16) and "The impact of environmental factors on leakage in the Anglian Water region" by Dr Timothy S. Farewell PhD

[53] Reference AFW04 'What our Customers and Stakeholders Want' report version 6

Our strategy & core pathway for water network resilience to climate change

The ambition of our network calming activity is to offset and mitigate this emerging risk to protect our customers' supplies and avoid additional disruption in our communities. Our ambition is to achieve this through the best value approach, maximising additional benefits in doing so. Renewal of all the highly vulnerable mains in the period would prove costly and extremely disruptive so we aim to offset the increases by implementing a suite of network calming technologies between 2025 and 2050.
Network calming aims to deliver a reduction in the additional number of mains bursts caused by hydraulic failure modes (e.g. those caused by transient water pressures within the network) to the same degree as the increase caused by climate change.

Our core pathway focuses on addressing the projected increases in bursts from the benign emission climate change scenario RCP 2.6, ensuring we remain 'low regret' with the option to increase activity to offset higher climate change scenarios as needed over later investment periods.

The initial 5-year investment will lay the groundwork, focusing on innovative techniques beyond the conventional technologies we are deploying through base expenditure. Our investments between 2030 and 2050 will deliver the modular profile benefits using these technologies. Our approach is adaptive, continuously monitoring the impact of climate change on our burst rate and adapting our network calming programme during each planning period, ensuring that we meet our ambition in the most cost-effective manner.
Our efforts will build on existing innovation activity, for example, we are partners with the Ofwat innovation 'Safe Smart System' project which focuses on embedding long-term operational resilience in the next generation of water systems and taking the first steps to achieve autonomous control. By harnessing the learnings from the Safe Smart System project's technologies and predictive capabilities, our intention is to take cutting edge approaches to network calming, discovering more efficient and deliverable approaches.

	2025 - 2030	2030 - 2035	2035 - 2040	2040 - 2045	2045 - 2050
Network calming - enhancement (number of bursts)	10.03	29.67	39.10	48.26	57.01
Network calming - base* (number of bursts)	73.43				

Table 45: Burst benefits delivery profile base and enhancement 2025 – 2050

*Network calming base programme will maximise our use of conventional technologies such as standard pressure reducing valves (PRVs). This will be fully delivered between 2025 - 2030 and will help to ensure sustainable levels of asset health along with our main renewals base programme.
The enhancement investment profile required to mitigate climate change impact over the 25-year period is outlined in Table 46 below:

Key enhancement investment activities	Delivery phasing total costs (£)				
	2025 - 2030	2030 - 2035	2035 - 2040	2040 - 2045	2045 - 2050
Network calming programme between 2025 - 2030 to optimise the network	£8.781m				
Use of innovative technologies to mimic modular profile benefits of benign emission scenario RCP 2.6		£15.308m	£9.238m	£9.660m	£9.963m

Table 46: Key enhancement investment activities

The investment costs for 2030 to 2050 have been developed using unit costs per burst benefit of the investment between the 2025 to 2030 period,

assuming technology-driven cost reductions will offset the diminishing returns as it is applied to our water network.

Between 2025 and 2030 we will conduct research into innovative techniques and technologies, which will help us on the journey to have an optimised and automated network, increasing network visibility real time and the quality of our data. The programme of work during 2025 and 2030 will be the most cost-beneficial network calming activity that can be implemented on the network, based on currently available technologies, detailed below in Table 47.

Programme	Component	Capex (£m)
Critical valve & smart valve ops programme	Smart Valves for all DMA boundary Valves	£2.250
Watchkeeper programme	Permanent Trunk Main Transient Monitoring	£2.175
Enhanced pressure management	Pressure Management Optimisation	£4.356

Table 47: Network calming activity breakdown & costs, all proposed to be delivered within the 2025 - 2030 investment period

The benefit of these activities will be:

- **Bursts –** 10.03 bursts per year prevented
- **Leakage –** 3.37 Ml/d reduction
- **Interruptions to supply –** 6.09% reduction
- **CRI –** 0.1% improvement

Alternative pathways for water network resilience to climate change

Due to the uncertain nature of climate change projections, we will conduct continuous monitoring of the climate change impact on our network**.** This will identify if the burst rate exceeds/is less than our projections. We will then adapt our investments at each AMP accordingly. In this way we will proactively manage the emerging risks while also ensuring that we make the best value, 'low regret' decisions.

Climate change:

Decision Point	2027 – Continuous monitoring of the climate change impact on our network will provide better quality of data to adjust climate change impact projections in preparation for our next price review. Alternative pathway will be triggered should the impact of climate change on burst rate exceed the projections for benign scenario RCP 2.6.
Trigger Point	2030 – point at which higher rate of investment commences to meet the increasing risk level
Point in which the pathway deviates	2030

Table 48: Decision Point, Trigger Point and Point in which the pathway deviates for the alternative pathway in the climate change scenario

The cost profile for the adaptive pathway to mitigate extreme emission climate change scenario RCP 8.5 is shown in the Table 49 below:

Key enhancement investment activities	Estimated cost	Delivery Phasing total costs (£)				
		2025 - 2030	2030 - 2035	2035 - 2040	2040 - 2045	2045 - 2050
Adaptive pathway - Use of innovative technologies to mimic modular profile benefits of extreme emission scenario RCP 8.5	£98.85m*	0	£39.283m	£19.047m	£19.940m	£20.579m

Table 49: Cost profile alternative pathway – climate change

*The investment costs for 2030 to 2050 have been developed using unit costs per burst benefit of the 2025 to 2030 investment period.

Cost benefit analysis indicates that this alternative pathway required in the adverse climate change scenario may not be cost beneficial. Given the increased scale of activity under this pathway we would seek to maximise, we believe further efficiencies in unit cost may be achieved and/or additional benefits may be realised.

Core pathway activities to safeguard future options

Our core pathway focused on addressing the projected bursts up to those forecast for the benign emission climate change scenario RCP 2.6, ensuring we remain 'low regrets'. It will create a foundation of understanding that allows increasing levels of mitigation should adverse climate change scenarios be realised.

Rationale of water network resilience to climate change

Identification of core and alternative pathways

The network calming investment includes several different approaches to mitigate the additional climate change driven increase in mains bursts within our network. Whilst each approach provides resilience to climate change, they also provide secondary benefits to leakage, interruptions to supply and CRI. Each approach provides slightly different benefits across these performance measures per unit of cost. We have undertaken economic analysis to examine various combinations of these approaches in discrete options. Table 50 displays the options that could then be considered and tested as part of accepting a viable core pathway for the network calming 25-year investment programme.

Foundations of water network resilience to climate change

Assumptions

We have made several assumptions within our economic analysis to inform our decision-making. Where material uncertainty exists within assumptions made for key drivers of our analysis, we have undertaken sensitivity analysis to ensure robust investment decision-making. Benefits are based on insights from within the water industry, taken from where other companies have already begun trialling or implementing similar technologies and the expected benefits are understood. We have also had third-party consultancy verification of these forecasts. Although diminishing returns will be seen, we have assumed that benefit unit rates will remain constant through technology advances and efficiencies being achieved. Further explanation is provided within our Technology scenario testing.

Performance improvements from base expenditure

Whilst this investment is focused on addressing the additional impact of climate change on our network. We have also been ambitious in what we can achieve from base costs through our 25-year asset strategy. Over the next 25-years we intend to deliver over 2000 km[54] of mains renewals from base costs, whilst also investment of £17.59m of network calming activity from base between 2025 - 2030. This base activity will deliver continued reduction in mains bursts performance across the period, use of emerging technologies, and approaches to manage the operation and underlying asset health of our network. Our 25-year asset strategy modelling indicates that we can achieve a further 14% reduction in mains bursts per annum by 2050, from a 2025 baseline.

Uncertainties

The severity and frequency of extreme weather events and evolving climate patterns are difficult to predict with certainty, this leads to challenges in planning. The strategy will need to maintain high degree of adaptability to account for this uncertainty. In addition, the degree to which our base investment in mains renewal will replace climate vulnerable mains and therefore reduce the need for other measures is not certain. Our base investments will be based on the optimal investments to maintain asset health, using the very latest data sets to inform targeting of replacement each year. It is plausible that this could gradually negate the need for further investment within the final 10 years of the LTDS period.

Uncertainties that cannot meaningfully be alleviated

Due to the modular nature of our delivery plan, our network calming strategy will be sufficiently adaptive to alleviate these uncertainties through the five-year investment cycle.

[54] Km of Main renewals to maintain 0.4% rolling average over the next 25 years and meet leakage requirements.

Table 50: Economic analysis of options for the Water Network Resilience to Climate Change LTDS core pathway

Option	Category	Description	Decision	Reasons for Decision
1	Baseline	Do nothing	Baseline (Do nothing or maintain) - rejected	This option would not support our LTDS ambition to increase our network's resilience to high-impact low-probability events for secure supply for our customers.
2	Best Value	Application of existing technologies between 2025 - 2030. Post 2025 - 2030 application of a suite of innovative technologies to cover the benign climate change scenario (RCP 2.6) aligning to Ofwat LTDS guidance, with modular profile benefits.	Preferred option / Core pathway - Adopted	We believe this option provides the best balance of cost and feasibility of delivery, achievement of ambition, and social and environmental benefit.
3	Mid Cost – phased to achieve RCP2.6 profile of benefit	Application of existing technologies between 2025 - 2030. Post 2025 - 2030 replacement of climate vulnerable mains to cover the benign climate change scenario (RCP 2.6) with modular profile benefits.	Alternative Pathway 1 - rejected	While option 3 would results in meeting our ambition to tackle the benign emission climate change scenario, it is not the most cost-effective option for our customers.
4	Highest Cost – phased to achieve RCP8.5 profile of benefit	Application of existing technologies between 2025 - 2030. Post 2025 - 2030 application of a suite of technologies to cover the extreme climate change scenario (RCP8.5) aligning to Ofwat LTDS guidance, with modular profile benefits.	Alternative Pathway 2 - rejected	Whilst option 4 was the most ambitious and would result in the greatest progress to tackle the extreme emission scenario for climate change, it is not a cost-effective solution for our customers.
5	Alternative solution type	Replacement of all climate vulnerable mains (1146 km).	Rejected	Cost prohibitive, additional £234m within period, accounting for 0.4% renewal already being funded from base across the period.

6.2 Resilience - flood resilience

Our ambition for flooding resilience
UK water companies face increasing flood risks due to climate change. Our 25-year ambition is to enhance resilience against river, surface, and groundwater flooding. This investment aims to reduce water supply disruptions, pressure issues, and water quality concerns during extreme weather. Our flooding LTDS aligns with government flood resilience expectations and adapts to climate change, population growth, and abstraction reduction scenarios.

Type of Flooding Event	Magnitude (Return Period) of Flooding Event Mitigated by our Core Pathway
Fluvial	A 1 in 100-year event, + climate change allowance, + three hundred millimetres freeboard
Pluvial	A 1 in 100-year event, + climate change allowance, + three hundred millimetres freeboard (where reasonably practicable)
Groundwater	A 1 in 30-year, plus climate change allowance (where reasonably practicable)

Table 51: Type and magnitude of flood event our core pathway is designed to mitigate

What our customers and stakeholders say
Our customers generally don't associate flooding with water supply disruptions; they focus on bursts and leaks. Resilience isn't their top investment priority. However, both household and non-household customers support investments for unexpected events and extreme weather, surpassing regulatory requirements. They expect future planning and quick issue resolution, acknowledging some situations are unforeseeable[55,56]

Our strategy and core pathway for flooding resilience
Our flood strategy safeguards production sites during extreme floods, maintaining water quality and reducing carbon impact without harming the environment or raising flood levels. We improve flood risk understanding, enhance site resilience, and cooperate with local authorities. We will invest in 142 flood-prone sites over the LTDS period.

Figure 12: Developing best value solutions

Our base spending maintains existing flood resilience infrastructure at river and groundwater sites. We use EA flood data to enhance works and procedures, accounting for climate change, population growth, and abstraction reductions.

Adaptive plans align with the government's WISER expectations, addressing flood-related supply risks and WRMP factors. These plans rely on climate and population forecasts, along with a flood scenario water supply contingency plan. Investments between 2030 and 2050 progress our flood resilience goal, protecting production sites and ensuring uninterrupted water supply during extreme floods.

Our 'no regrets' core strategy reduces supply interruption and low-pressure risks, alleviating 95% of flooding-related issues. It also mitigates water quality threats, meeting government requirements.
Future legislation might demand stricter flood mitigation. Scenario testing confirms the adequacy of our core pathway against various futures.

[55] Report 134 - Affinity Water PR24 Customer Engagement, Impact MR 12/09/22

[56] Report 200 - Customer Priorities for Long Term Ambitions – Qual Report. ICS 16/11/22

Core pathway activities to safeguard future options

Option #	Category	Description	Decision	Reasons for Decision
1	Baseline	**Do nothing** Manage flood impacts using existing provisions and procedures, accepting increasing risk levels	Baseline (Do nothing) Rejected	This wouldn't align with our long-term goals to protect customer supply and the environment.
2	Best Value	**Core pathway** Appropriate physical works to mitigate water supply risks over 25 years: • Enhancement: 17 fluvial, 71 pluvial & 5 GW sites. • Base: 14 fluvial, 8 pluvial & 6 GW sites. Develop flood risk assessments and flood management contingency plans.	Preferred Option / Core Pathway - Adopted	We believe this option provides the best balance of cost of delivery, achievement of ambition and feasibility to deliver as concluded by our NVP and risk & value assessments
3	Lowest Cost	**Basic physical works** Basic physical works to manage water supply risks: • Enhancement: 12 fluvial & 6 pluvial sites. • Base: 5 fluvial, 2 pluvial & 1 GW sites. Develop flood risk assessments and flood management contingency plans.	Pathway to be revaluated at 5-year investment cycles	This option would not provide sufficient dependable mitigation of water supply risks.
4	Midpoint	**Blended approach** Basic & appropriate physical works to mitigate water supply risks: • Enhancement: 16 fluvial, 43 pluvial sites & 3 GW sites. • Base: 13 fluvial, 8 pluvial & 3 GW sites, Update of flood risk assessments. Develop flood risk assessments and flood management contingency plans.	Pathway to be evaluated at 5-year investment cycles	We believe this option would not provide as much value as the core pathway to achieve our LTDS ambition of best protecting our customer's supply and limit environmental impacts.

Table 52 Alternative flood resilience management options

Our core pathway addresses climate change, population growth, and water challenges to reduce flood damages, save costs, and enhance water supply resilience. Collaboration with external stakeholders, such as the EA and local councils, strengthens regional flood management and shared responsibility.

This strategy is indispensable, serving as a 'no-regrets' investment even in favourable conditions. It includes rigorous risk assessments and dynamic planning, ensuring flexibility to address high and low-impact scenarios and mitigate potential impacts.

Rationale of our flooding resilience

Identification of core and alternative pathways

We prioritise flood resilience for a sustainable water supply. After risk and value workshops with stakeholders and flood risk assessments (fluvial, pluvial, groundwater), we found gaps, emerging risks, and opportunities. To gauge customer impact, we used asset criticality data, considering factors like served population, redundancy, and response time. We also assessed flood-prone sites, aligning assessments with previous work to identify flood resilience options.

Over the next 25 years, our core plan focuses on enhancing 17 fluvial, 71 pluvial, and 5 groundwater flood-prone sites, alongside modernising flood risk assessments and regional strategies. This core plan, chosen for its value through net present value assessment, will be adapted to 2050 to ensure resilience against extreme weather, climate change, population growth, and abstraction reductions.

Costs (£m)	2025 - 2030	2030 - 2035	2035 - 2040	2040 - 2045	2045 - 2050
Enhancement expenditure	1.064	11.480	1.246	1.768	2.528

Table 53: 25-Year Flood Resilience Planned Expenditure Totex Forecast

Our expenditure plan prioritises critical assets most affected by flooding in the early LTDS period, followed by ongoing investment between 2035 and 2050 to maintain assets and address emerging risks.

Period	High Population Forecast Scenario	Percentage Change in Population Between Periods (High)	Low Population Forecast Scenario	Percentage Change in Population Between Periods (Low)	Population Difference Between Forecast Scenarios	Percentage Difference Between Forecast Scenarios
2025 - 2030	4,306,474	4.17%	4,125,946	4.11%	180,528	0.06%
2030 - 2035	4,450,458	3.24%	4,263,912	3.24%	186,547	0.00%
2035 - 2040	4,567,653	2.57%	4,377,960	2.61%	189,692	-0.04%
2040 - 2045	4,709,373	3.01%	4,515,183	3.04%	194,190	-0.03%

Table 54: 25-year high and low population growth forecasts.

Foundations of our flooding resilience

Assumptions

The costs for each site are based on Affinity Water's past projects, adjusted to 2022/23 base. Flood protection design follows a 1:100-year event with climate change allowance (20% flow increase) and meets current regulations.

Pluvial flood risk analysis uses 2013 maps from the EA. Fluvial flood risk is determined from our PR09 Flood Risk Assessment. Each site is considered separately.

Performance improvement from base expenditure

Flood resilience base expenditure shall improve the effectiveness of our existing flood resilience assets and procedures. Updating our flood risk assessments with current modelling data will allow us to improve our site-based flood management and water supply continuity plans. Existing flood protection measures shall be examined and adapted if necessary to manage forecast climate change, population growth, and abstraction reduction risks. Table 55 below provides an overview of the flood resilience enhancement expenditure activities we have planned for the period between 2025 and 2050.

	2025 - 2030	2030 - 2035	2035 - 2040	2040 - 2045	2045 - 2050
Enhancement expenditure	£1.064m 3 fluvial sites, 2 pluvial sites, 1 GW site.	£11.480m 14 fluvial sites, 39 pluvial sites, 4 GW sites.	£1.246m 30 pluvial sites.	£1.768m Emerging flood related water supply risks.	£2.528m Emerging flood related water supply risks.

Table 55: Flood resilience LTDS enhancement expenditure activities.

Uncertainties

Flood risk assessments involve uncertainty. We integrate cutting-edge EA flood modelling data into our short-term flood resilience plans, shaping our overall long-term strategy. Ideally, our current measures are based on conservative risk assessments, showing their robustness, and reducing long-term investment needs. However, uncertainty beyond 2050 due to climate change and population growth requires us to outline various scenarios. We monitor key metrics to guide adjustments in our long-term flood resilience strategy, emphasizing responsiveness and effective risk mitigation.

Uncertainties that cannot meaningfully be alleviated

Legislative uncertainties challenge our long-term flood resilience strategy. Unlike technical or environmental uncertainties, legislative uncertainties hinge on governance shifts, policy changes, and legal frameworks. These uncertainties can alter investment priorities, resource allocation, zoning regulations, and land use policies. We proactively mitigate legislative uncertainty by maintaining a flexible approach in our plans. Although we can't eliminate these challenges entirely due to the unpredictable nature

of legislation, our adaptable core pathway ensures we can meet flood resilience goals despite changes in laws and regulations.

6.3 Resilience - single points of failure

Our ambition for Single Points of Failure
Over 25 years, we aim to enhance resilience against low-likelihood, high-impact events caused by single points of failure (SPOFs). Our programme will reduce the risk and mitigate the consequences of individual asset failures, ensuring a reliable water supply and improved interruption performance for our customers.

Costs (£m)	2025 - 2030	2030 - 2035	2035 - 2040	2040 - 2045	2045 - 2050
Single Points of Failure	5.140	12.812	12.812	12.595	11.922
Connect 2050	13.722	-	-	-	-

Table 56: Enhancement expenditure for the SPOF programme.

What our customers and stakeholders say
Ensuring a safe water supply is a top priority for all customer segments, especially non-household customers (AFW04). Customers typically don't immediately associate resilience with supply security, often thinking of issues like bursts or leakage instead. The connection between climate change and increased resilience risk isn't always top of mind. However, when we explore further, customers expect proactive planning, especially for operational and asset-related risks, with some consideration for environmental risks (AFW04).

Our strategy and core pathway for Single Points of Failure
To achieve our ambition, we compiled a list of potential threats to our assets and customer supplies, drawing from historical root cause analysis and industry best practices. We assessed asset criticality to standardise resilience risk evaluation. From this, we pinpointed key assets posing single points of failure, potentially affecting over 500,000 customers. We evaluated intervention options following a Green Book-based process, covering the 4Rs of resilience mitigation, leading to three distinct programs of work targeting various SPOF types within our water network system (Table 57)

	2025 - 2030	2030 – 2035	2035 - 2040	2040 - 2045	2045 - 2050	Total Cumulative
Improvement to Interruption to supply greater than 3 hours associated to the SPOF programme (in seconds)	7	10	8	5	4	34

Table 57 - SPOF LTDS enhancement expenditure.

The following related activities will be delivered as part of our base expenditure:

- Trunk mains and distribution mains renewals (asset condition-related)
- Asset heath surveys
- Asset modelling including asset health
- Flushing
- Trunk mains maintenance
- Growth – network reinforcements
- Pressure management
- Non-infra capital maintenance

This enhancement investment will significantly improve our performance commitments. We expect a 7-second reduction in supply interruptions during 2025 and 2030 and a 34-second improvement by 2050 due to our SPOF programme.

The programme will also reduce long-duration supply interruptions, lower the risk of single events failing our yearly target, and decrease the risk of community disruption during emergency closures of critical infrastructure like the A2 or Great Northern Line.

Our core pathway prioritises high-impact SPOF risks, maintaining cost-effectiveness. This approach is considered 'no regrets' based on our favourable cost-benefit analysis. Implementing it early between 2025 and 2030 reduces the impact of adverse scenarios.

Our investment principle prevents asset stranding over 25 years. Our SPOF enhancement strategy in our LTDS prioritises the 2025 to 2030 period for short-term customer needs and adaptability for future planning periods, if necessary. Annual monitoring of key metrics, like single events with over 30 seconds of interruptions, ensures adaptability to changing risks and long-term investment needs.

To achieve our stated ambition of reducing supply interruptions to under three hours by 2050, our SPOFs programme will consider:

- new repair techniques that will enable a reduction the response time to repair, and subsequently reduce the interruption to supply if a main fails.
- new restoration techniques, in addition to the widely used double line-stops and by-pass solutions for mains under six inches and pressured tankers that can supply customers while the repair is carried out.

In our scenario testing against Ofwat Common Reference Scenarios, no material impact requiring an alternative pathway was found. We are confident in the resilience of our core pathway against various future scenarios.

Technical optioneering and cost development

SPOF vulnerabilities can disrupt water service, affecting daily life, hygiene, household tasks, and businesses. To gauge customer impact, we grouped pipe elements by consequences, conducted Critical Link Analysis (CLA) using InfoWorks Water Supply (WS) Pro software, and correlated data with our extensive network of 389,802 cohorts. Verification was done through local insights and hydraulic modelling, followed by the Risk and Value (R&V) process to select optimal solutions. Costs were based on PR24 cost models, adjusted for engineering complexities. The R&V process, applied throughout asset planning, balances risk, performance, and cost with stakeholder input.

Rationale of Single Points of Failure

Identification of core and alternative pathways

Our optioneering approach for the SPOF core pathway involved a multi-stage process to evaluate options for validity and ensure an investment program aligned with our SPOF LTDS. We began by identifying primary stress and shock events leading to low-likelihood, high-impact asset failures. This, coupled with asset criticality, generated potential interventions to mitigate these issues. We evaluated these interventions based on reliability, adaptability, and evolvability (Table 58). The outcome is our core pathway for SPOFs LTDS, aligning with our resilience goals.

Process Categorisation		SPOFs evaluation
Reliability	Uncertainty of performance	Can the proposed mitigation options cope with uncertainty around supply/demand?
	Ability to persist and recover	How vulnerable is the mitigation option to other hazards?
	Resilience of supporting services	What are the risks and uncertainties around the mitigation options? Does the storage in the reservoir allow enough time for a repair?
Adaptability	Timing and warning of events	Expected frequency of failure? Duration of failure? Can we plan for the failure?
	Availability of temporary responses	Can we use the restoration team to provide response and recovery solution mitigating the impact of the failure of the SPOF? E.g., use of line stop and bypass for pipe with below 6inches, use of pressurised tanker etc.
	System connectivity, redundancy, and flexibility	Does the system have adequate connectivity? Do we have capacity surplus?
Evolvability	Flexibility and diversity of planned changes	How scalable and modular are the proposed investments? How diversified are the proposed investment?
	Deliverability of planned changes	What is the lead team to deliver the schemes? How reliant are we on external bodies?
	Monitoring and management of changes	How flexible are the planning pathway? What is the level of engagement of our stakeholders? How well do we understand the impact of the failure of the SPOF?

Table 58: Evaluation of SPOF LTDS

The optioneering process generated options, listed in Table 59, for consideration and testing in defining a viable core pathway for the SPOF 25-year investment programme.

Option	Category	Description	Decision	Reasons for decision
1	Baseline	Manage failure and build headroom within underlining Interruption to Supply performance to allow for potential SPOFs failures.	Baseline (Do nothing or maintain) - Rejected	This would not support our overall LTDS ambition and would not achieve our overall ambition of supply interruptions over 3 hours by 2050.
2	Best Value	(Appropriate physical works to mitigate SPOFs between 2025 - 2030) Enhancement: Top 2 trunk mains crossing critical national infrastructure + Top 17 Low likelihood, high impact SPOF Infrastructure assets identified by Criticality Link Analysis and validated by customer delivery colleagues	Preferred option/Core Pathway - Accepted	We believe this is the best-balanced option to achieve our long-term ambition, while providing best value for the environment and our community.
3	Lowest Cost	Lowest cost option: Top 2 trunk mains crossing critical national infrastructure + Top 5 Low likelihood, high impact SPOF Infrastructure assets identified by Criticality Link Analysis and validated by customer delivery colleagues.	Basic physical works - Rejected	This option would have the lowest cost to our customers' bills, but less beneficial and ambitious than the preferred options. This is the minimum we should undertake to hope to achieve supply interruptions over 3 hours by 2050.
4	Mid-Point	Top 2 trunk mains crossing critical national infrastructure + Top 5 to top 17 Low likelihood, high impact SPOF Infrastructure assets identified by Criticality Link Analysis and validated by customer delivery colleagues	Blended approach	The blended approach would aide in achieving our SPOF ambition while considering lower costs, however, does not provide the best value for our customers.

Table 59: List of options considered and tested

The core pathway will deliver the best value interventions to target the low-likelihood high-impact SPOFs with the highest risk to best improve the resilience of our asset base against the stresses and shocks likely to materialise in the 25-year period.

Foundations of Single Points of Failure

Assumptions

For our SPOF LTDS, we rely on accurate asset health data, combining industry best practices, historical failures, and pipe sample analyses spanning 31 years. PIONEER, our asset renewal planning tool, was employed to create 25-year investment plans for capital maintenance, including climate change scenarios. Our goal is for cost-effective investment that maximises customer service levels.

We assume all SPOFs are identified, thanks to 100% coverage of our water distribution network in our internal modelling system, maintained at an 85% confidence rate through biannual critical link analysis.

To minimise new SPOFs over 25 years, we've revised standards outlined between 2020 and 2025, actively mitigating potential SPOFs due to factors like population growth or abstraction reductions. However, some SPOFs may arise from activities such as record corrections or network complexity, like pressure management schemes that risk burst mains.

Our business cases adhere to the Green Book methodology, aligning with Ofwat's expectations and proving cost-effective, especially when investment pace is constrained by affordability and customer bill impact.

4.2 Performance improvements from base expenditure

The SPOFs programme aims to enhance our Interruption to Supply performance commitment during the planning period. It will increase asset resilience against low-likelihood, high-impact failures. Besides a projected 44-second reduction from base expenditure, this will decrease interruption prevalence and duration, resulting in an estimated average 7-second annual reduction in supply interruptions across the network between 2025 and 2030.

Uncertainties

Our LTDS ensures resilience to plausible scenarios, considering future uncertainties, especially climate change. Adaptability is crucial due to unknown severity. Extreme weather, changing precipitation, and climate-driven demand shifts can alter intervention benefits.

The cost and affordability of redundancy works are another uncertainty. We must maintain customer affordability. Rising costs may increase customer bills, impacting the SPOFs programme's viability.

These uncertainties will be continuously monitored, guiding potential adaptations in the SPOFs investment programme.

We believe we can address all uncertainties through our core pathway and minor adaptations in our 5-year investment process.

6.1 SEMD - cyber security

Our ambition for cyber security

Cyber security is vital for protecting critical national infrastructure, especially in the water sector, where disruption can have significant consequences.

Under SEMD 2022 regulations, water companies must address security risks, including cyber security, in compliance with the NCSC's Cyber Assessment Framework (CAF).

As water networks become more automated and connected, the risk of evolving cyber threats grows. Ensuring cyber resilience is crucial, especially with remote system control.

Our ambition is to maintain robust and resilient systems in the face of increasing cyber threats, adhering to regulations and CAF. We aim not only to meet but exceed requirements by building resilience throughout system design, implementation, operation, and management, reducing the risk of successful cyber-attacks.

What our customers and stakeholders say

Cyber security isn't a top-of-mind concern for customers; they prioritise a safe and reliable water supply[50]. In resilience discussions, operational and asset-related threats are areas where customers perceive our control. Environmental and weather risks, despite our limited control, are viewed as important. Third-party and socio-political risks are less emphasized by customers and are seen as standard risk mitigation measures for any company[51].

Our strategy and core pathway for cyber security

We have a clear strategy for achieving our ambition by investing £6.12m between 2025 and 2030 to enhance our cyber security capabilities. This aligns with NCSC's CAF requirements enforced by the DWI. The enhancement projects between 2025 and 2030 include Zero Trust Network Access (ZTNA), designed for a remote and internet-connected workforce, enhancing protection against cyber threats.

We will also invest in Operational Technology (OT) Network Access Control Systems and a Data Loss Prevention Solution to continually monitor and address security gaps. These systems support various technology scenarios, including new systems, Software-as-a-Service (SaaS), and secure access to legacy systems. We will build on this foundation up to 2050, regularly assessing options to maintain, improve, enhance, or transform our cybersecurity to stay ahead of threats and remain resilient.

	2025 - 2030	2030 - 2035	2035 - 2040	2040 - 2045	2045 - 2050
Enhancement investment in cyber security systems (£m)	6.120	6.645	7.215	1.267	8.06

Table 60: Enhancement investment in cyber security systems 2025 - 2050 (£m)

Appendix Tables 53-56 show scenario testing of our core pathway against Common Reference Scenarios. No material impact requiring an alternative pathway was found. We are confident the core pathway is resilient against various future scenarios.

Technical optioneering and cost development

We have assessed four options to surpass CAF requirements.

PR24 Options	Maintain	Improve (60%)	Enhance (70%)	Transform (Preferred Option – 100%)
Compliance or CAF Profile	**Basic Profile**	**Sector Profile**	**Enhanced Profile**	**Resilience Profile**
Capability against cyber attack	Limited Capability Cyber-attack	Compliance Driven Sector Profile	Moderate Capability Cyber-attack	Risk Driven for Heightened Cyber Threat
Technology		Zero Trust Network Access (100%)	Zero Trust Network Access (100%)	Zero Trust Network Access B2.c Privileged User Management B4.a Secure By Design
Technology		OT network monitoring system (100%)	OT network monitoring system (100%)	OT network monitoring system to reduce cyber and operational risk • CAF C1a-d Security Monitoring • CAF C2.a System Abnormalities for Attack Detection • CAF C2.b Proactive Attack Discovery
Training		CAF C1e Monitoring Tools and Skills (40%)	CAF C1e Monitoring Tools and Skills (100%)	CAF C1e Monitoring Tools and Skills
Resources and Equipment		CDC - CAF C1 Security Monitoring (Out of Hours £1m)	Cyber Defence Centre (CDC) | CAF C1 Security Monitoring (Outsourced – £1.75m)	Cyber Defence Centre (CDC) | CAF C1 Security Monitoring (in-house £2.35m)
Resources		DWI CAF B2.b (100%)	DWI CAF B2.b (100%)	DWI CAF B2.b - Device Management
Service		-	-	DWI CAF B3.a - Pen Tests and technical assessments
Product		-	-	DWI CAF B3 – Data Security - Data Loss Prevention solution.
Service		Security architecture review (100%)	Security architecture review (100%)	Security architecture review for critical system B4.a Secure By Design
Resource		DWI CAF B4.d (40%)	-	DWI CAF B4.d Vulnerability Management
Service		DWI CAF D1 (40%)	-	DWI CAF D1 Response and Recovery Planning
Service		DWI CAF D1 b (60%)	-	DWI CAF D1 b - Capability to enact the incident response plan IT/OT incident response expertise (retained service)
Resource		DWI OT/IT (40%)	-	DWI OT/IT cybersecurity knowledge and skills development B6.b Cyber Security Training A1.c -
Total		Least Cost Option - £3.5m	Alternative Option 1 - £4.14m	Preferred, Best Value Option - £6.12m

Table 61: Summary of the potential options considered for our cyber security LTDS

We have identified different security systems that will help us to exceed the requirements of the CAF. These systems will increase the speed of threat detection and remediation.

Additional benefits from our core pathway for future scenarios

Our core pathway facilitates Affinity Water's growth in service users and transition to cloud platforms. It employs Zero Trust Architecture (ZTA) to reduce cyber risks and optimise cloud migration benefits, particularly for the expanding remote workforce. The increased use of cloud platforms allows efficient IT resource management through scalable allocation, avoiding overprovisioning, and reducing energy consumption.

Core pathway activities to safeguard future options

The core pathway features ZTA, safeguarding cloud assets, remote workforce, and asset management. ZTA enables rapid technology adoption with secure testing of new systems and cost-effective Cloud-hosted Software-as-a-Service (SaaS) applications. It also ensures confidence in pursuing slower technology scenarios by offering secure access to hard-to-replace legacy systems. This ensures cyber resilience from 2025 to 2050.

Rationale of cyber security

Identification of core and alternative pathways

Affinity Water prioritises risk assessment over compliance, following DWI's direction to prioritise the CAF based on sound risk management. This approach aligns with the ongoing journey toward higher cyber security maturity, ensuring resilience in the future.

Foundations of cyber security

Assumptions

Our strategy assumes stable regulatory requirements during 2025 and2030, making planning for changes beyond that period challenging. We also anticipate an increased risk of cyber-attacks, especially OT-specific ransomware. Our enhancement project aims to address both regulatory compliance and cyber security but predicting the exact cyber risk level is challenging. We will closely monitor the evolving landscape, including the rise of AI-assisted cyber-attacks in the next two AMPs.

Performance improvements from base expenditure

We have invested in AI and ML-driven security technology with autonomous response for our base investment. Additionally, we prefer preconfigured systems with constant threat updates to detect new attacker methods. Our enhancement investments in ZTN, Access Operational Technology will further boost threat detection and response speed.

Uncertainties

Whilst we anticipate that the rate of technology advancements over the next two planning periods will accelerate, we do not know how quickly this will happen or the exact effect it will have on cyber-attacks. However, our enhancement projects will ensure we are well-equipped to deal with cyber-attacks and have the software to detect any threats and defuse them.

Uncertainties that cannot meaningfully be alleviated

We are also unsure about the future of regulatory requirements. These are likely to change in line with the changing technology landscape. However, as we do not have metrics on this, it is impossible to predict how or when the regulatory requirements will need to change. Any changes to regulatory requirements over the coming planning periods will potentially require us to change our enhancement investments to meet the changing regulatory requirements.

6.2 SEMD - Physical Security

Our ambition for Physical Security

The SEMD 2022, based on The Water Act 1991, mandates UK Water Companies to address national security risks. Affinity Water has assessed its security risks and aims to meet both government requirements and identified improvements using a mix of base and enhancement investment. Base work involves maintaining existing systems, like CCTV for improved alarm verification at covered reservoirs, card readers for better access control at

operational sites, and hatch alarms for "Basic" classified reservoirs, though not mandatory, to enhance security. Enhancement work is prompted by a DEFRA review in 2022, requiring changes at Egham Water Treatment Works and Sunnymeads Intake. This aligns with SEMD legislation, enhancing security for 20 years. The goal is to match the security level of Affinity's other CNI sites using internal security standards

What our customers and stakeholders say
Customers typically don't prioritise security concerns for water supply; they focus more on issues like bursts and leakage. Surveys reveal expectations that the water company ensures supply security. We collaborate with the National Protective Security Agency (NPSA) and regional Police Counter Terrorist Security Advisors (CTSA) to monitor sector-specific threats and response plans

Our strategy & core pathway for Physical Security:
This strategy is a "no regrets" investment required for Water UK Security Standard compliance, SEMD legislation. Enhancements between 2025 - 2030 include new CCTV systems and access management to achieve CNI compliance at newly classified sites. Our technology approach requires interchangeable components to provide flexibility against technological changes or supplier issue.

The core pathway satisfies short term commitments to the site security and legislative requirements[57] whilst enabling flexibility in the medium to long term, should SEMD requirements dictate.

	2025 - 2030	2030 - 2035	2035 - 2040	2040 - 2045	2045 - 2050	Total
Spend (£)	£950k	-	-	-	-	£950k

Table 62: Projected enhancement costs: 2025-2050

As highlighted in our approach to scenario testing our core pathway against the Ofwat reference scenarios it was determined that there was no material impact that would require an alternative pathway. Following this testing we are confident that our core pathway is sufficiently resilient against various futures.

Technical optioneering and cost development

The enhancement work is a legislative requirement. The optioneering undertaken has focused around attaining the required level of security for the best value and operational functionality with a consideration to the longer-term legacy maintenance costs and reliability.

We have worked with the supply chain and framework providers to develop options and validate costs within our plans. Our security maintainers are a national company, with a high degree of expertise, and work closely with our internal experts to guide and support the long-term strategy.

Additional benefits from Core Pathway for future scenarios

Our core pathway is based on industry standard techniques and interchangeable hardware that is systems agnostic, which will allow us to adapt to future scenarios and requirements as they evolve.

Core pathway activities to safeguard future options

Care has been taken to select technology that is interchangeable and does not unduly limit the future options and constrict the possible future direction.

[57] WATER INDUSTRY ACT 1991: SECTION 208. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1057909/water-security-emergency-measures-direction-feb2022.pdf

Through learning and monitoring of the systems in place, robust and resilient systems can be identified which will minimise costs going forward.

Rationale of Physical Security

Identification of core and alternative pathways

We have considered five different options that have been dictated by compliance with UK security standards. After a series of risk and value workshops, we identified the least cost, best solution to implement and removed all other activities from the Physical Security business case.

Option #	Category	Description	Decision	Reason for Decision
1	Baseline	Do not carry out the upgrade work	Baseline (Do nothing or maintain) - rejected	This option will not meet the correct security level
2	Best Value	Carry out the work	Preferred Option/Core Pathway - Adopted	Uses the latest technology and reliable equipment already proven to give longevity.
3	Lowest Cost	Don't automate the new gates. Use cheaper CCTV cameras	Alternative Pathway 1 – Rejected	This option will not be compliant, and the CCTV cameras would fail and need replacing more often
4	Mid-point	This is similar to the best Value option where reasonable cost cameras are used.	As above – see Best Value Option 2	The option offers compliance without over scoping the work.
5	Highest cost	Expensive but very good reliable cameras and gates with latest technology in video access control.	Alternative Pathway 2 – Rejected	This will ensure reliability of the cameras. However, costs were too high.

Table 63: Summary of the potential options considered for our Physical Security Long-Term Delivery Strategy

Foundations of Physical Security

Assumptions

We have assumed that the security threat level to the UK Water Industry will not significantly change over the lifetime of the LTDS. We will continue to monitor intelligence from the government to ensure we stay alert to any changes.

We have assumed that the current retailers remain solvent and don't increase costs beyond the expected 3-5% increases, so that our current software and hardware remains available and affordable to purchase. Technology software can be updated by the supplier to improve service or mitigate risk. New versions of the software will sometimes be required if the old version is no longer supported.

Performance improvements from base expenditure

A base maintenance schedule will maintain the security assets across the whole company, (replacing doors and electronic measures), ensuring what is installed is functional and fit for purpose.

Our enhancement investments will ensure we comply with the Water UK Security Standards at our newly reclassified sites.

Uncertainties

Uncertainties in the supply chain and third parties continuing to supply and support a service, mainly for software within the electronic security area where AW already have software in situ but have not asked for a budgetary provision should a supplier go out of business.

The security equipment installed by UK Water companies is to a set standard, monitored by the Government Security Service. If the standards change, then all UK Water Companies will liaise with DEFRA and the Security service and address the changes as all will be affected.

Uncertainties that cannot meaningfully be alleviated

Lastly the stage 5 criticalities review conducted by the Cabinet Office (2023) will raise the issue of increased CNI for the UK water sector. However, at this stage it is impossible to gauge the impact the review will have, and investment agreements will be needed to reflect any new works required.

6.3 SEMD - emergency planning

Our ambition for meeting SEMD requirements for emergency planning

The Security and Emergency Measures Direction 2022 (SEMD) states that all water companies must have a well-documented and exercised plan they can activate in case of an emergency. Companies must ensure the continuation of its water supply functions and, in the event of an unavoidable failure of piped supply, ensure that a minimum supply is provided by alternative means. This requires the identification of risks and suitable assessments, monitoring and mitigation with a robust plan in place to deliver during such situations. Documented risks and their mitigations should be maintained, tested and reviewed frequently to account for any changing circumstances. The solutions and how they are implemented should be communicated coherently across the core teams.

At present, Affinity Water must be able to supply 20,000 of its urban population with 10 litres of water per person per day in the first 24 hours. The minimum threshold to meet SEMD requirements between 2025 and 2030 will increase to a minimum of 1.5% of our domestic population with 10 litres of alternative water per person per day for the first five days and then 20 litres per person per day thereafter. This will increase our worst case and planning threshold to 1,276,359 litres per day.

Our ambition is to exceed the minimum thresholds whilst ensuring that our vulnerable customers have access to alternative supplies, particularly during 'business as usual events' such as bursts and before the SEMD minimum thresholds are required. We are committed to supporting our customers on the priority services register and are increasing the number of customers registered. This will require us to provide alternative supplies for a greater number of customers during emergencies.

Affinity Water must also plan for reasonable national worst-case scenarios. This has been identified at government level as being a 6sixday national power outage (NPO). We plan to increase our fleet of mobile power generators to help mitigate this risk and provide flexibility in our approach to site-specific power issues, maintaining key sites and customer supply.

What our customers and stakeholders say

Our customers don't automatically identify resilience as an area of high concern when relating external factors to the impact of delivering a secure supply of water – they more naturally think of bursts or leakage when they think about resilient supplies. The link between climate change and increased resilience risk is also not top of mind. However, there is an assumption we will plan ahead – with operational and asset type risks being seen as the most logical to plan for, with a level of mitigation against more environmental risks.[58]

Our strategy and core pathway for meeting SEMD requirements for emergency planning

Our strategy is to ensure that there is a continued water supply for customers by establishing a tankering capability that can be mobilised in emergencies to maintain customer supplies, as well as purchasing more mobile generators to maintain power to key sites during outages.

This strategy is a 'no regrets' investment, enabling us to provide a better response in emergencies which will occur to varying degrees across all plausible scenarios. Under the new measures, we must be able to increase our provisions of alternative water from the current minimum of 200,000 litres

[58] What Customers & Stakeholders Want V5 pg. 29

per day to the new minimum. We propose to do this, principally, by purchasing four water tankers in addition to increasing locally held bottled water (84% of which would be made up of tankering) to provide an alternative supply, as opposed to increasing bottled water storage by over 100%. To meet our long-term ambition, we propose to invest the following amounts over the next five AMPs:

Key enhancement investment activities	Estimated cost (£)	Delivery timing
Tankers x 4, Enabling work for tankers, Mobile generators x 3, plug in points x 30 Satellite SIM cards, Lorry with Moffatt (to move water), Increased bottled water storage facility, Kit, including hoses and fittings	4.339	2025 - 2030
Tankers x 4 (Increasing fleet to 8) Mobile generators x 3, plug in points x 30	4.234	2030 - 2035
Tankers x 8 – 4 x new (increasing fleet to 12) and replacing tankers during the 2025 – 2030 period More satellite SIMS Replacing lorry with Moffatt	4.709	2035 - 2040
Tankers x 8 – 4 x new (increasing fleet to 16) and replacing tankers during the 2030 – 2035 period	4.732	2040 - 2045
Tankers x 4 – Maintaining fleet of 16, replacing tankers during the 2025 – 2030 period	4.423	2045 - 2050

Table 64: Proposed enhancement investments

The proposed enhancement investments have been sequenced to allow us to build up the processes and proficiency of tankering, and to account for future challenges such as population growth, climate change and changes in regulation through modular increases. We expect greener technologies such as hydrogen-powered tankers to be available in the later years of the LTDS period, with a transition to biodiesel in the meantime.

Looking ahead beyond 2050, the pressures of climate change and population growth will become more acute, continuing to drive the need for this investment.

Technical optioneering and cost development

Detailed optioneering is provided within our PR24 business plan appendices AFW14, demonstrating that tankers offer greater NPV than additional bottled water capacity, with a suite of additional value offered.

Rationale for meeting SEMD requirements for emergency planning

Identification of core and alternative pathways

We have undertaken comprehensive benchmarking activities to understand industry best practice for emergency planning, alongside gathering information from reports of previous emergencies such as Ofwat's 'Out in the Cold' report following the 'Beast from the East' extreme weather event in 2018. This has influenced our preferred option for our core strategy to be tankering to provide alternative supplies during emergencies and incidents. Tankering is viewed as the best value option for providing alternative supply as it can supply much greater volumes, with increased flexibility and reducing plastic waste. To provide 1.5% of our population with bottled water, we would require 1,490 pallets and the means to distribute them.

Previously, our approach for alternative supplies has required moving, unloading and distributing up to 520 pallets of water using several lorries. This is extremely time consuming and wasteful. To provide the equivalent using tankers, we will only require four 30,000 litres tankers with five runs each to supply 600,000 litres of water to our customers. This is a much larger quantity than that which was possible with bottled water and above the minimum required, set out in the SEMD.

Alternative supply will become more flexible with the use of tankers, as there are more options for where this water can be injected into the

network (e.g. direct injection, reservoir filling or customer 'tap bars'), and we will be less reliant on the supply chain during national events.

The proposed options that were considered are shown in Table 57, along with the outcome of the optioneering assessment and reasons for the decision.

Option #	Category	Description	Decision	Reason for decision
1	Baseline	No investment – reliant on basic third-party contracts to provide tankering solutions	Baseline (Do nothing or maintain) - rejected	This option will not address any of our long-term risks or comply with SEMD obligations
2	Best Value (mi-point)	In house tankering to satisfy current DWI minimum requirements and an estimated projection over time	Preferred Option/Core Pathway - Adopted	This will address population growth in line with estimated timings and enable us to develop processes in good timing
3	Lowest Cost	Enhanced contracts with third parties to provide alternative water solutions, this is limited by national demand and supply levels during incidents and cannot always be guaranteed	Alternative Pathway 1 – Rejected	This option will not address any of our long-term risks
4	Highest cost	Accelerate tanker procurement so all 16 are on fleet between 2025 - 2035	Alternative Pathway 2 – Rejected	This will ensure any acceleration of population or worse case is mitigated straight away. However, costs were too high.

Table 65: Summary of the potential options considered for our emergency planning LTDS

Foundations of meeting SEMD requirements for emergency planning

Assumptions

Our proposed investment pathway assumes that the DWI do not update the SEMD requirements beyond where they are currently. Future changes are likely to impact our ambition and our core pathway.

Performance improvements from base expenditure

Our base costs will contribute to our SEMD compliance through provision of all emergency response capabilities beyond those directly relating to tankering for alternative water provision.

Uncertainties

Most uncertainties are encompassed by our scenario testing, with associated monitoring and response approaches laid out accordingly. One further area of uncertainty is cost of low emission tankers, which may materially affect the cost of the pathway, although this is not anticipated to do so sufficiently to impact the outcome of optioneering i.e. moving away from tankering for alternative water provision.

Uncertainties that cannot meaningfully be alleviated

There are no material uncertainties that cannot be alleviated.

Board Assurance statement

Introduction

We, the Board of Affinity Water Limited, are pleased to submit our Long-term Delivery Strategy (LTDS) alongside the PR24 business plan for 2025 to 2030 and beyond. We accept ownership of, and accountability for, the development of this strategy. We have been fully engaged in the development and preparation of this LTDS, owning the strategy and using our formal Board meetings to lead and provide strategic direction to management, to challenge the proposals and to consider our customers' and stakeholders' views through our engagement programme. We have supplemented our regular meetings with structured strategy sessions and have used these to challenge the proposals for the LTDS.
Further details on Board Governance and our Assurance Framework can be found within the Board Assurance statement section of the PR24 business plan.

Meeting the criteria

The Board has challenged company management to satisfy itself that Affinity Water's Long-Term Delivery Strategy satisfies the six criteria taken from the guidance from Ofwat set out in Table 66. Updates were given to the Board at regular Board meetings and during Board Strategy sessions in November 2022 and June 2023. Given the novelty of the LTDS requirements, our board were keen to be directly involved in its development and in assuring that this met the regulatory guidance from Ofwat, in conjunction with further strategy sessions focusing on our statutory programmes, followed by a more detailed technical and strategic assurance. The key agenda items and decision points of these are set out in Table 67, followed by how each of the six criteria have been met.

SDS (2020 to 2021)

We began engagement with our Board in July 2020, where it was agreed to develop a Strategic Direction Statement which would help shape the PR24 business plan and place it within the long-term ambition and vision for the company.

In August 2020, the Board heard from an independent expert, Dr Elaine King, CEO of the Chilterns Conservation Board, on the importance of chalk streams, and the need for abstraction reform. In January 2021, the Board reviewed progress to date in developing the ambition and outline of the SDS. Four scenarios were considered along the two dimensions of environmental and social health, and the results of recent engagement with a wide range of stakeholders was considered. In March 2021, the four ambition statements developed around the themes of environment, customer, resilience and communities were considered and agreed, along with the results of recent customer engagement commissioned to drive and inform the development of the SDS. In June 2021, the Board considered a near final draft of the SDS, and the document was published in August 2021. It was re-published in January 2022 following a change in CEO, with an updated Foreword.

November 2022

We discussed the requirements of the LTDS guidance and assurance requirements with the Board. We then discussed how the SDS ambitions and customer research had informed the suite of LTDS ambitions. We provided a costed view of the LTDS core pathway to achieve these ambitions and the resultant bill impact on our customers. The Board challenged specific areas of ambition in how they were reflected in both our strategy and customer views, in addition to challenging the phasing of activity over the 25-year period.

June 2023

The Board challenged us on how the WRMP was aligned with the LTDS in conjunction with the Ofwat guidance. We fed back this challenge through our WRSE planning to ensure that we met the guidance.

August 2023

The Board reviewed a full draft of our LTDS, alongside KPMG audit reports.

Criteria	Evidence
Reflects a long-term vision and ambition that is shared by the Board and company management	We set out our overall strategic direction through our Strategic Direction Statement. This translated into an initial set of ambitions, which were costed and then tested with the Board in November 2022. This was revisited in March 2023 following further stakeholder engagement and more scenario testing and cost analysis. The Board finally confirmed that the Long-Term Delivery Strategy reflects their long-term vision and strategy in the June 2023 Board Strategy Day session. This was supported by the assistance of external strategic and technical assurance of Atkins and KPMG.
Is high quality, and represents the best possible strategy to efficiently deliver its stated long-term objectives, given future uncertainties	Over the course of two Board Strategy Day sessions, the Board challenged both the approaches to the strategy development and realisation of the long-term objectives. In addition, the Board have undertaken 4 specific reviews of our statutory programmes WRMP and WINEP to satisfy itself that our statutory programmes represent efficient delivery of statutory obligations. In conjunction, the Board has assured itself of this through technical assurance provided by Atkins, focusing on investment planning process, ensuring best practices approaches have been undertaken. KPMG also provided strategic assurance to ensure adherence to meeting the Ofwat guidance on long-term delivery strategies.
Is based on adaptive planning principles	The board were taken through the expectations and guidance of the Long-Term Delivery Strategy development to understand how adaptive planning principles should be applied over the course of March and June 2023 sessions. The Board challenged on how adaptive planning principles had been applied and the resultant adaptive pathways. KPMG strategic assurance was also used to provide confidence in meeting the Ofwat guidance on Long-Term Delivery Strategies.
Has been informed by customer engagement	Our board have been provided with insight into how the customer views have informed all discretionary elements of our planning process. This was specifically done in how we set out our ambitions within the non-statutory areas and the preferences in the options that we set within our pathways. The Board provided explicit challenge in how these have been actioned. In the November 2022 session, the Board challenged how our level of ambition reflects the customer views on the rate of lead removal from our network. This resulted in a material change in the phasing of our lead removal programme. In conjunction, our Independent Challenge Group has also scrutinised our investment planning approach to ensure this reflects the best interests of customers. This included deep dives into how Service Measure Framework benefit valuations were developed, how these were applied in investment planning and how our overall portfolio was selected.
Has taken steps to secure long-term affordability and fairness between current and future customers	Our Independent Challenge Group have reviewed and challenged our research in long-term affordability and intergenerational fairness and how customer views this have been reflected in our approach to developing the LTDS. This includes bill impact testing of our specific ambitions and the overall bill impact of our pathway with our water communities. Customers highlighted leakage and mains repair as areas of focus for the LTDS while water quality contact, greenhouse gases and business demand are the least prioritised areas. We see support for immediate increases in bills to focus on these high priority areas but there are real concerns for current bill impacts and investing now for the future is seen as a fine balance.
Will enable the company to meet its statutory and licence obligations, now and in the future	The board have undertaken 4 specific reviews of our WRMP and WINEP statutory programmes to satisfy itself that our statutory programmes represent efficient delivery of our statutory obligations. KPMG stat assurance. KPMG also provided strategic assurance to ensure adherence to meeting the Ofwat guidance on long-term delivery strategies

Table 66: Six LTDS Ofwat criteria

Responding to feedback from Ofwat

As a new requirement for PR24, we have engaged extensively with Ofwat and the wider industry to ensure we meet expectations and to confirm that our strategy brings best value to our customers. In developing this strategy, Ofwat has provided valuable feedback on the emerging strategies. In the table below, we explain how we have accounted for this feedback within our strategy.

		Feedback from Ofwat	How we have accounted for this in our final strategy
Affinity specific feedback	Ambition	Use factors listed in Ofwat's guidance to inform ambition	Our Ambition chapter lays our factors referenced within Ofwat's final LTDS Guidance
	Core and alternative pathways	Core Pathway from AFW's dWRMP does not align with the definition set out in Ofwat's guidance and combines reference scenarios for testing. The core pathway should set out low-regret investments	Our core pathway now sets out low-regret investments linked to WRMP. We have worked with Water Resources Southeast to ensure our LTDS core and adaptive pathways reflect a low regret core pathway and the results of scenario testing aligned to the Ofwat final guidance.
		Explain clearly how the low-regret investment has been identified. These investments should be flexible and modular	We have used both existing long-term strategy inputs and broader optioneering to consider a comprehensive suite of options to deliver each aspect of our ambitions, as outlined in the Summary of our Rationale section. The core pathway was then tested against the common reference scenarios to ensure they were low/no regrets as also described in this section. Economic testing has been undertaken for all pathways to ensure they represent the optimum investments to achieve our ambitions. We have adopted flexible, modular approaches wherever practicable, for example in the phasing of our Grand Union Canal scheme.
		Clearly describe decision and trigger points for alternative pathways, particularly if enhancement expenditure will be requested at PR24	Trigger and decision points have been laid out in our Strategy Chapter
	Scenario Testing	Each of the common reference scenarios should be tested to evidence that the low-regret investment has been identified and long-term outcomes will be efficiently met in a range of plausible futures.	Scenario testing approaches and findings are laid out within each strategy. The impact of these reference scenarios is set out within each strategy with associated costs shown in data table LS5.
		The estimated impact of each individual reference scenario from 2025 to 2050 should be clearly set out	
		Scenario testing should be used as well as the selection and timing of activities in the core pathway and development of alternative pathways	Scenario testing has been a fundamental component of the development and refinement of each of our pathways, including phasing of activity. Each strategy lays out the findings of scenario testing and how this has shaped the strategy and created alternative pathways where appropriate.

		Low abstraction reductions scenarios need to be tested	This scenario has been tested in line with the guidance for each strategy within the Appendices.
		Technology scenarios need to be tested against the sensitivity of options to different futures and justify the optimal timing and sequencing of activities	This scenario has been tested in line with the guidance for each strategy within the Appendices. The findings of sensitivity testing of options to differing futures within the technology scenario has reshaped elements of our strategy, for example in the phasing of our lead removal activity.
	Base expenditure	Demonstrate that long-term performance improvements from base expenditure are being considered	Details of how long-term performance improvements from base expenditure has been considered is included within Strategy chapter
	Engagement	Clearly explain how the strategy has been informed by customer preferences	An explanation of how customer preferences have informed our strategy is included within our Ambition and Strategy chapters.
Industry feedback	Ambition	Most companies are exploring their long-term ambition collaboratively with their customers, including taking steps to understand and respond to the interests of future customers.	We have engaged with customers in the development of our Strategic Direction Statement, which set the basis of our ambitions. We have subsequently taken specific ambition testing with customer groups to set our ambitions for non-statutory investments such as Lead and Resilience.
		Companies need to include the bill impacts of achieving their ambitions	An explanation of the bill impacts of achieving our ambition is included within the Strategy chapter.
	Core and alternative pathways	Adaptive planning should take account of uncertainty and be able to adapt to different futures	Our scenario testing takes account of the key uncertainties we face, with alternative pathways created wherever potential impacts were forecast as material
		More needs to be done to identify low-regret investment, establishing what activities are needed now and which can be scheduled later	We have used both existing long-term strategy inputs and broader optioneering to consider a comprehensive suite of options to deliver each aspect of our ambitions, as outlined in the Summary of our Rationale section. The core pathway was then tested against the common reference scenarios to ensure they were low/no regrets as also described in this section. Economic testing has been undertaken for all pathways to ensure they represent the optimum investments to achieve our ambitions. We have adopted flexible, modular approaches wherever practicable, for example in the phasing of our Grand Union Canal scheme.
		Companies need to embed adaptive planning principles as part of their decision-making, including isolating low-regret investment and identifying where investing to support future options is likely to be cost-effective. They should also consider optimal timing and criteria for decisions about 'higher regret' investments in future	We have carefully considered this through our scenario testing and pathway development, as laid out in our Rationale Chapter and within each investment strategy.
		Some companies' approach to the core pathway might not identify low-regret investment in line with Ofwat's definition	We have ensured our core pathway meets the requirements as outline in 3.3.2 of the final guidance, as outlined in our Strategy and Rationale chapters. All early investments of the core pathway are required across benign and adverse scenarios alongside investigations to determine optimal investments over later scenarios e.g. WINEP investigations. Adaptive pathways have been created to meet adverse scenarios.
		Investment options might not be optimal if a wide range of plausible scenarios have not been tested against	We have tested all investments against the common reference scenarios and our wider scenario 'Catchment Care'. In addition, wider uncertainties have been considered for each investment strategy to ensure our core pathway is optimal.
	Scenario	Strategies need to be robust to a wide range of futures. This includes applying the common reference scenarios for	

		technology and abstraction reductions in line with our guidance, alongside other common and company- specific scenarios.	
		Companies should prioritise the investment options that are most frequently chosen across a wide range of plausible scenarios, as well as setting out the criteria applied to select these options	Our approach to scenario testing derived low/no regrets investments as those that were necessary across numerous scenarios
		The scenarios should be used to ensure that their strategy will optimise the investment programme against future uncertainty	
		There needs to be sufficient and convincing evidence of scenario testing to support the assertion that the strategy meets the ambition under all scenarios	Each of our investment strategies lays out the findings of our scenario testing and the specific analysis we have undertaken.
		Some companies risk justifying short-term investment based on very low probability scenarios.	Our wider scenario approach describes how we have ensured that only plausible scenarios were considered
		Companies should provide evidence to demonstrate that the scenarios underpinning their investment programme are possible, if not necessarily the most likely.	
		Companies are expected to use the reference scenarios to explore the potential impact of technological development on the relative costs and benefits of options.	Each of our investment strategies considered the impact of the fast and slow technology CRS. The results of this testing can be found within each investment strategy.
		Several companies told us the scale of abstraction reductions is a significant uncertainty around future enhancement requirements. It is therefore important that companies use the relevant reference scenarios in line with our guidance.	This scenario has been tested in line with the guidance for each strategy, as outlined within our Investment Strategy documents.
	Base expenditure	Some companies are not sufficiently challenging themselves to deliver stretching levels of performance from their base allowance, in the short and long term.	As detailed within our Ambition chapter, we have challenged ourselves to deliver stretching improvements from base across the investment period, accounting for past improvements achieved from base across the industry.
		The strategy should be built on a good understanding of how the company will effectively manage its assets, both in the short and long term. It should explain how the company's approach to base and enhancement activities will contribute to meeting long-term outcomes	The development of our LTDS has been built upon 25-year asset strategies, using deterioration modelling to inform the investment requirements in base to deliver forecast performance levels. Contribution of base and enhancement investments to achieving long-term outcomes are detailed within our Ambition chapter.
	Engagement	Companies should use customer engagement to inform their ambition, the selection and sequencing of key investments, and considerations about affordability and fairness between current and future customers	An explanation of how customer preferences have informed our strategy is included within the How customer & stakeholder views have informed the plan section.
		The views of wider stakeholders should inform the ambition and the core pathway	Wider stakeholder views have been gathered through our WRMP & WINEP stakeholder engagement sessions alongside our LTDS stakeholder sessions in March 2023. Each investment strategy lays out where these views have informed our ambition and investments.
		Company Boards should challenge company management to ensure the strategy is the best it can be, and provide assurance according to our requirements	Our Board has been highly engaged with the LTDS throughout its development, with KPMG providing assurance that this LTDS meets the requirements of the guidance. Details are provided within our Board Assurance chapter.

Table 67: Responding to Industry and company specific Ofwat feedback of the LTDS

Further detail on how our strategy mitigates our key issues and challenges

Global issues impacting Affinity Water		
Issue	**Expected short, medium & long-term impact on Affinity Water[59]**	**How we have reflected this within our ambition and key mitigations within our core pathway**
Climate change impact	Short term • Increases in demand due to high temperatures (heatwaves), 1.71 Ml/d by 2029/30 5.58 Ml/d by 2049/50, • Equipment and asset failure due to extreme weather events • Reduced availability of ground and surface water due to drought 12.89 Ml/d, (benign common reference scenario, RCP2.6) Medium term • Increases in demand due to higher temperatures throughout the year and particularly during summer Long term • Increase in competition for, and price of, raw water imports • Changes to raw water quality as a result of changes in rainfall and temperature patterns	Our Resilience ambition will ensure we manage supply and demand to ensure we have a resilient supply of water over the long term. It will also provide assets and systems more resilience to the impacts of climate change and improve our ability to respond to the increasingly frequent extreme weather events. Our Environment ambition also includes meeting Net Zero of our own emissions by 2045, as our contribution to reducing the extent of climate change. **Mitigating Strategies - WRMP, Resilient Assets & Systems, SEMD, Net Zero** Short term • We will increase our deployable output by 0 Ml/d and interconnector capacity by 43 Ml/d by 2030 • We will reduce our reliance on ground water abstraction by 21.19 Ml/d by 2030 • We will reduce demand by 58.57 Ml/d by 2030, leaving more water in the environment and reducing peaks of demand • We will mobilise 5 tankers to provide better response to maintain supplies during extreme weather event by 2030 Medium term • We will increase our deployable output by 50 Ml/d by 2040 • We will reduce our reliance on ground water abstraction by 105.63 Ml/d by 2040 • We will reduce demand by 183.16 Ml/d (cumulative benefit) by 2040 Long term • We will increase our deployable output by 100 Ml/d by 2050 • We will increase our interconnector capacity by 443 Ml/d by 2050 • We will reduce our reliance on ground water abstraction by 200.65 Ml/d by 2050 • We will reduce demand by 277.87 Ml/d by 2050 • We will provide enhanced levels of treatment for 101 Ml/d of output by 2050
Biodiversity loss	Short term • Deteriorating biodiversity on our land limiting our ability to achieve net gain (BNG) requirements associated with wider infrastructure upgrade between 2025 - 2030, such as sustainability reductions.	Our Environmental ambition will progressively protect, restore and enhance biodiversity within our landholdings and across the catchments of our region. • Integrated biodiversity requirements included throughout PR24 business cases,

[59] Short term – 1-5 years, medium term 5-15 years, long-term 15-25 years

	• Deterioration of biodiversity on our landholdings against the baseline impacts our ability to meet the 2025 - 2030 performance commitments. Medium term • Population increases and land use change in our catchments resulting in loss of biodiversity and habitats negatively impacting on the water environment and meeting WFD objectives • Increased prevalence of INNS on third party land and within our landholdings Long term • Biodiversity and habitat loss through climate change, population growth and associated land use change impacting ability to meet future BNG and performance commitment obligations	• Created a core biodiversity delivery and advisory capability including recruitment of in-house team of ecologists. • Programme of INNS management within our landholdings and schemes to work with partners to manage INNS on third party land in our communities. • We have also integrated biodiversity considerations into our approach to catchment and nature-based solutions. Biodiversity is a core component of our WINEP approach. **Mitigating Strategies – WINEP** Short term • Targeted investment to achieve 122 biodiversity units across our land by 2030, with detailed ecological assessments across all our key sites Medium and Long term • Our "catchment first" approach to protecting, restoring and enhancing biodiversity taking a Natural Capital approach will result in £29.822m investment between 2025 - 2030 in protecting, restoring and enhancing drinking water/chalk stream catchments with further investment across the life of the LTDS.
Cyber crime	Short term • Advanced threat actors, including State sponsored groups, who target businesses for various motivations including monetary gains through ransom attacks and for political statements. Medium term • Increasing frequency of low sophistication Operational Technology compromises. Simpler attacks, where actors with varying skill levels and resources use standard IT (Information Technology) tools and techniques to gain access to and interact with exposed OT (Operational Technology) systems. Long term • Common and single-attack tools compromise many IT and OT systems from various vendors, and the proliferation of these tools makes it easier for sustained and relentless attacks against legacy systems that cannot keep up with the changing threat tools and processes.	Based on the assumption that cyber breaches are inevitable, our resilience ambition includes enhancing our cyber security controls to continually protect our systems with a holistic multi-year plan that helps Affinity Water: • to build our capability to **identify** and manage cyber risks • develop and implement appropriate **safeguards** to ensure delivery of critical services • implement plans to **detect** and **respond** to a cybersecurity event • maintain plans for **resilience** to restore any lost services **Mitigating Strategies – SEMD** Short term • We will invest £6.12m between 2025 - 2030 to improve our cyber security capabilities across our people, and our systems Medium and Long term • We will build on these cyber security systems continually to ensure we keep pace with the leading edge of cyber security
Natural resources crisis	Short term • Supply chain issues limit the availability electric vehicles and public charging infrastructure. • Increases in competition for green electricity tariffs Medium term • Multiple challenges associated with delivering carbon free electricity as standard across the UK. • New technologies and innovation, supported and approved by regulators are required to enable reduction in embedded emissions.	Our Environment ambition encompasses reaching Net Zero, driving us to reduce our consumption of valuable resources such as those used in chemically intensive water treatment. Our Customer ambition encompasses progression towards a 'lead free' society, reducing dependents on the finite resources such as orthophosphoric acid. **Mitigating Strategies - Net Zero, Lead** Short term • We will transition to an EV van and car fleet by 2030

	Long term • Multiple challenges associated with ability of supply chains to decarbonise.	Medium term • Alongside our investment for low carbon construction, we will build upon our existing PAS2080 accreditation to ensure we minimise the need for resources through our investments, maximising the reuse of existing materials and assets Long term • By 2050 we will remove 76,000 lead pipes, forming the foundation to cease orthophosphoric dosing for our 11 high risk zones
Natural disasters and extreme weather events	Over time these will become both more frequent and extreme, in line with climate change impacts notes above.	Our Resilience ambition includes increased resilience of our asset systems and improving our ability to respond to disasters and events. **Mitigating Strategies - Resilient Assets & Systems, SEMD** • Mitigations are as per climate change impact mitigations
Misinformation & disinformation	Short term • Misinformation and disinformation were added to the World Economic Forum's list of global risks in 2022-2023, following on from the Global Risks Perception Survey (GRPS). The GRPS results suggest that misinformation and disinformation pose as a more severe threat than terrorist attacks, the cost-of-living crisis and severe mental health deterioration. • We have seen a lower confidence in public institutions impacting society, for example resulting in less effective pandemic responses, with misinformation and disinformation increasing vaccine hesitancy. Medium term • Over the next 10 years and beyond, misinformation and disinformation are anticipated to increase, reinforced by the erosion of social cohesion and proliferation of social media and unregulated news sources. • Growing conflict within societal values could precipitate regulatory changes across a broad range of areas impacting the water industry, from education, employment, immigration, and the environment. Long term • Severity over the longer term is much less understood, with uncertainty on whether driving forces within society may be reduced, or whether the short-medium trend could continue to increase the size of the issue.	Our Communities ambition focuses on building trust through increased transparency of our operational and financial performance, providing customers and stakeholders with the accurate information needed to hold us to account and proactively counteract relevant misinformation or disinformation.

Issues specifically facing our sector

Issue	Expected short, medium & long-term impact on Affinity Water	How we have reflected this within our ambition
Bill affordability		As part of our Customer ambition, in conjunction with direct financial support for those unable to afford bills and implementation of tariffs, we have also phased our LTDS to deliver our ambitions to keep bills affordable and will continue to revisit the affordability of our long-term plans at each five-year planning period.

Customer trust	Trust in the industry is at an all-time low, partly due to the shift in attitudes towards combined sewer outfalls, which are affecting perception of Affinity Water despite being a water only supplier. The trend of future customer trust may further erode without action, with increasing expectation on the services we provide and performance in key areas such as leakage. Misinformation and disinformation also have the potential to impact customer trust over the short, medium and long term.	Customer trust is essential for any regulated utility, which is why this plays a central role in our Communities ambition. Never more so in an era of increasing misinformation and disinformation and a critical requirement to influence customers on key issues such as consumption. We intend to address this with increasing transparency on our operational and financial performance alongside increasing reporting of wider public value delivered within our Annual Reports and increasing customer protections through price control deliverables.
Contamination of water sources	There are multiple different causes of deterioration of raw water quality, some of which are predictable and others which cannot easily be modelled. Short term • In the short term, we expect to continue to see, on average, one site per year contaminated by 3rd party pollution activity. This will continue to 2050. Medium term • In the medium term, we expect to see more sources affected by nitrate contamination as concentrations increase, possibly exacerbated by climate change-related weather patterns. We also have a number of sources that are at risk from migrating contamination due to abstraction reductions. Long term • In the long term, we may see deterioration of the River Thames' water quality related to climate change resulting in the need for a change in treatment process at the four surface water treatment works.	Our strategy for managing deterioration of our raw water sources is to continue our periodic monitoring and to review online and sample data to assess the risk profiles for our sources. Where we foresee the risk exposure rising, we will trigger the development of mitigation options. **Mitigating Strategy - Raw Water Deterioration** Short term • We are enhancing treatment capability at 10 sites to address raw water contamination risks Medium and Long term • By 2050 we will enhance treatment at 14 sites, with an adaptive pathway to address greater contamination risk
High population growth	Based on the ONS18 projection, used for the low demand scenario and our local projections for population growth, used for the high demand scenario, we have forecast a range of: Short term by 2030 4,125,950 (+4%) to 4,306,470 (+8%) medium-term by 2040 4,377,960 (+10%) to 4,567,650 (+15%). long-term by 2050 4,660,520 (+17%) to 4,860,000 (+22%).	Our Resilience ambition includes providing resilient water supplies, across the full plausible range of population growth forecasts. Our full LTDS has been tested against these extremes to ensure we have appropriate adaptive plans. **Mitigating Strategies – WRMP** Short term • We will increase our deployable output by 0 Ml/d and interconnector capacity by 43 Ml/d by 2030 • We will install 511,000 AMI smart meters (including new builds and Optants) to drive down per capita consumption alongside a sustained behavioural change campaign Medium term • We will increase our deployable output by 50 Ml/d by 2040 • We will install 1.239,000 (new builds and optants) AMI smart meters to drive down per capita consumption Long term • We will increase our deployable output by 101 Ml/d by 2050

Issues facing Affinity Water specifically		
Vulnerability of chalk streams	Approximately 10% of globally rare and important chalk stream are in our supply area. Without additional interventions, these will deteriorate progressively by 2050 and beyond through the impacts of climate change, abstraction, population increase (and the associated developments) and agricultural and urban land management impacts.	As part of our Environmental ambition, we aim to end all unsustainable abstraction we undertake from chalk aquifers. Our Resilience ambition accounts for the shortfall this creates through reduced demand, accessing new water sources and reconfiguring our water network **Mitigating Strategies – WINEP, WRMP** Short term • We will reduce our reliance on ground water abstraction by 21.19 Ml/d by 2030, leaving more water in the environment and reducing peaks of demand Medium term • We will reduce our reliance on ground water abstraction by 104.83 ML/d by 2040 Long term • We will reduce our reliance on ground water abstraction by 200.65 ML/d by 2050
Climate change vulnerable mains	Approximately 7% of water mains are significantly vulnerable to the impact of climate change due to the material type and specific soil conditions of our region. In the short term, this will increase bursts by between 20-42 per annum by 2030. This will progressively increase to between 57-121 per annum by 2050.	Our Resilience ambition includes improving the physical resilience of our water network over the long term, through our network calming sub-strategy implementing enhancements to offset this affect. **Mitigating Strategies - Resilient Assets & Systems, Network Calming sub-strategy** Short term • We will deliver a range of innovative interventions across our network to reduce bursts to offset the effect of climate change, whilst undertaking further analysis to improve forecasts and identify new techniques to mitigate this issue Medium and long term • Building on our early innovation, we will adopt new technologies to continually mitigate this effect

Table 68: Issues impacting Affinity Water

Appendices – Scenario testing our core pathways

1.1 WINEP – biodiversity

Table 1 Climate change RCP 8.5 and 2.6 scenarios

Nature of impact	Climate change will lead to more frequent, erratic, and extreme weather events, including intense rainfall events, heatwaves and storms. Average annual temperatures will rise, particularly during the summer. Met Office research found that we can expect to experience the record-breaking temperatures experienced in 2018 (a temperature of 38.7°C was recorded at Cambridge University Botanic Gardens on 25 July) every second summer by 2050 (CCAR, 2021). Changes in seasonal temperature and rainfall patterns are likely to increase presence of pests and diseases which thrive in a warm and humid environment and play a large role in the loss of critical ecosystem services. For example, Ash Dieback is expected to kill 80% of ash trees across the UK. The loss of trees is significant because of the myriad benefits they provide. We have an industry-wide tree planting objective with our commitment to a net increase of 110,000 trees by 2030, against our 2018 baseline. Extreme weather is likely to impact habitats and species on our landholdings and increase the prevalence of INNS. Climate change may also impact migration and spawning patterns of eels and fish species, and therefore the need to ensure appropriate screening of intakes is in place.
Method of testing	We have expanded the work undertaken for our 2021 Climate Change Adaptation Report, along with informed expert thinking, to include a wider number of risks and their interdependencies. The benign and adverse scenario was assessed and determined through a risk-based review of the challenges posed by climate change detailed in our 2021 Climate Change Adaptation report. Our assessment has been informed by key infrastructure risks set out in the UK's national climate change risk assessment (CCRA3) that are relevant to our business. We mapped the risks in our Adaptation Report and the associated Addendum report, and we have used this information to test this strategy against these risks. This has been supported by a wider literature review of climate change impacts on biodiversity and INNS.
Extent of impact	We have considered the extent of the impacts identified in our Climate Change Adaptation Report and the associated addendum report. The impact of climate change on species and habitats is likely to be widespread and wide ranging. Species and ecosystems have evolved over very long periods of time and therefore the predicted rapid increase in temperatures and erratic weather patterns will force species to either adapt or face decline/extinction. Land management practices and decisions can have a key influence on species and ecosystem resilience to the effects of climate change. Biodiversity also has an important role in climate change adaptation. Strong evidence suggests that climate change already affects UK biodiversity, and this will intensify with further climate change. The impacts will affect species distribution, driving species further north likely resulting in increased migration of species from continental Europe. Climate change will also increase number and spread of NNS (including pests and diseases). Genetic diversity and reproductive rates will influence the ability of species to evolve and adapt, affecting distribution and numbers. Wetland and coastal habitats are likely to be impacted due to changes in water availability and impact of sea level rise.
Justification & Evidence	Under the 8.5 climate change scenario, we anticipate the following factors that would impact the delivery outcome and inform the adaptive pathway under this scenario: • Higher temperatures and erratic climatic conditions leading to increased risk of degradation of our landholdings and associated biodiversity. • Influence potential emerging contaminants adversely impacting biodiversity. • Higher temperatures leading to increase prevalence of INNS and emerging INNS and intense rainfall leading to greater mobilisation and spreading of INNS. • More intense rainfall leading to greater surface run off and pollutant loading from amenity and agriculture leading to negative impacts on aquatic ecology • Land use change resulting from extreme climate change leading to habitat loss and associated impacts to biodiversity Over time, this more extreme climate change scenario is likely to increase expenditure in areas such as asset protection, increased scale and pace of sustainability reductions and biodiversity measures, increased cost of catchment and nature-based solutions for biodiversity and increased scale and costs for INNS management. Creating resilience in our catchments now is important for long term sustainability for both water resources and ecology, to protect habitats for future generations and limit loss of wildlife. We are not able to quantify the impact of climate change and therefore do not have an adaptive pathway for either scenario. However, we will ensure we monitor climate change using established metrics and if an alternative pathway is needed in PR29, we will update the WINEP pathway 1 with an alternative pathway.
Ongoing monitoring	We will monitor this in a variety of ways including: • Ongoing ecological and BNG surveys of our landholding every four years (as a minimum) against our baseline between 2020 - 2025. • Macroinvertebrate and macrophyte surveys of chalk streams across our supply area • INNS surveys of our own landholdings and supporting wider catchment partners in monitoring of INNS in our catchments • Programme of tree surveys across our landholding managed through our in-house database (Ezytreev)

Table 2: Faster and slower technology scenarios:

Nature of impact	The roll out of the specific parameters set out in the faster and slower technology scenario within the LTDS guidance is considered unlikely to have a significant transformative effect on this strategy. Low carbon construction materials rather than convention building material under the faster technology scenario could have benefits for biodiversity where 'green' construction techniques are also incorporated into designs e.g. green roofs but this unlikely to have a material impact on the strategy. Full open-source datasets across the industry and other utilities could also for example assist in the treatment and management of INNS, with greater visibility of the location and extent of NNS, especially where new species are identified as a result of for example climate change influences or due to the development of new sources of water (e.g. SROs). We are utilising remote sensing to support habitat assessments and consider this has potential to future develop in areas such as remote identification of INNS. Consideration of opportunities to align with other drone and remote sensing used within smart water supply networks could also be explored. With the challenges of climate change and other land use pressures the use of wider technology has the potential to support our biodiversity ambitions. The development of new remote sensing technologies could help improve efficiency and coverage of habitat surveys. New techniques like eDNA analysis could assist with non-disruptive survey techniques for example for aquatic INNS or other species of interest e.g. Great Crested Newts. The development of new treatment/management techniques for INNS, such as biological controls, could also assist with the treatment and management of INNS on our sites and in the wider catchment. New fish and eel screening technologies also has the potential to improve effectiveness and provide greater ecological protection to fish populations in the River Thames.
Method of testing	We have considered the faster and slower technology scenarios on the effect on this strategy with SME and experience gained through delivery of our WINEP and biodiversity programmes between 2015 - 2025.
Extent of impact	It is inherently difficult to forecast the extent of the impact of a slower or faster technology scenario on this strategy we have considered through review by SMEs some wider benefits of innovation and technology. The development of remote sensing and eDNA techniques have the potential to increase the efficiency of INNS surveying and treatment.
Justification & Evidence	A faster technology scenario could lead to improved management of wastewater, improving aquatic ecology and more resilient habitats to support biodiversity. This would help reduce the costs of managing biodiversity in the aquatic environment and increase habitats created through increased wetland and other nature-based solutions for wastewater. Faster improvements in monitoring technology would improve decision making on management of biodiversity and implementation of nature-based solutions. This would drive efficiencies through being better informed to prioritise and target investments. A slower scenario would be likely to increase costs due to a slow rollout of wastewater solutions, leading to increased pollution issues, therefore increased costs to try and mitigate the impacts of this on biodiversity. We are unable to quantify what these scenarios would look like and the impact that each scenario would have. Therefore, we cannot form an alternative pathway for these scenarios. However, we will monitor the changes to technology over the coming years, and if necessary and metrics are available, we will update the LTDS with an adaptive pathway when it is refreshed in PR29.
Ongoing monitoring	We will monitor and adopt advances in technology to improve our monitoring and decision-making around biodiversity including: • Engaging with our Framework consultants, academic partners and others to identify future technologies such as satellite imagery and remote sensing. • Will ensure we are using the current biodiversity Metric (currently 4.0) and associated advancements. • Engage with water industry and wider biodiversity forums to track the latest technological developments.

Table 3: High and low demand scenarios:

Nature of impact	Under the high demand scenario, we will need to progress a greater number and scale of infrastructure and non-infrastructure schemes which has the potential to impact on habitats and species on our existing sites. Where additional land purchase is required for these schemes such as those included in the rdWRMP, we will need to ensure that we can meet both new planning requirements regarding biodiversity Net Gain but also ensure no-deterioration of habitat on our sites, in accordance with the 2025 - 2030 (and future) performance commitment. The high demand scenario will also trigger the need for new SROs which have the potential to introduce new INNS and will therefore require appropriate monitoring and management. The Low Demand scenario will require less infrastructure and non-infrastructure schemes and therefore there will be a reduced impact on biodiversity on our current and future landholdings.

Method of testing	This scenario has been assessed by SME and informed by dWRMP.
Extent of impact	Whilst inherently challenging to accurately forecast the extent of this impact, to reflect our approach to innovation and collaborative working, we have assumed that the guidance specific parameters will not have a material impact on this strategy due to other legislative requirements e.g. BNG planning requirements. Under the high demand scenario, we will need to progress a greater number and scale of infrastructure and non-infrastructure schemes which has potential to increase the scale of impact on habitats and species on our existing sites and third-party land. Where additional land purchase is required for these schemes such as those included in the rdWRMP, we will need to ensure that we can meet both new planning requirements regarding biodiversity Net Gain but also ensure no-deterioration of habitat on our sites, in accordance with the 2025 - 2030 and any further performance commitment. The high demand scenario will also trigger the need for new SROs which have the potential to introduce new INNS and increase the scale and extent to which current and future INNS could be spread. The Low Demand scenario will require less infrastructure and non-infrastructure schemes and therefore there will be a reduced impact on biodiversity on our current and future landholdings.
Justification & Evidence	Our dWRMP sets out how we will balance supply and demand considering housing and population growth. In both the low and high demand scenario, there will be increased development in the South-East and whilst BNG requirements under planning legislation will seek to address the loss of habitat on development sites there will be the potential for increased pressure on and fragmentation of habitats. There is likely to be a greater number of visitors to important sites for biodiversity e.g., sites within Areas of Outstanding Natural Beauty (AONB) and/or company owned designated sites e.g. Stockers Lake, which will make habitat protection more challenging, needing to balance public access with wildlife and conservation requirements. Additional investment is likely to be required under these circumstances to mitigate these impacts. However, we are unable to quantify the extent of the impacts, therefore we cannot create an adaptive pathway. If necessary and metrics are available, we will update the LTDS with an adaptive pathway when it is refreshed in PR29. This will be monitored through the strategic regional planning process and associated WRMP's developed through each AMP cycle, which in-turn will inform the development of the associated WINEP programmes.
Ongoing monitoring	We are surveying our landholdings to ensure we have baseline assessment from which we can monitor delivery and progress against our biodiversity strategy. This information will be used to inform future AMP requirements.

Table 4: High and low abstraction reduction scenarios:

Nature of impact	The high and low abstraction reduction scenarios have the potential to have an indirect negative impact on habitat and species on sites through new construction activities which will require mitigation but also result in benefits to chalk stream habitats and groundwater dependent terrestrial ecosystems through more water being left in the environment. Under the low abstraction reduction scenario we are likely to retain more of our existing sites and assets and therefore impact to biodiversity on these sites is likely to be lower. Under the high abstraction reduction scenario there will be a need for a greater level of infrastructure and non-infrastructure schemes to main supplies to our customers e.g. new trunk mains, boosters and service reservoirs, which has the potential to impact biodiversity on our sites, or on new landholdings where we need to purchase or work on these. Due to biodiversity Net Gain requirements, a greater level of infrastructure investment should also lead to an improvement in wider biodiversity. The high abstraction reduction scenario as set out in our rdWRMP includes several new SROs. These include new raw water transfers which have the potential to increase the risk of the spread of INNS (aquatic and terrestrial).
Method of testing	We have reviewed the high and low abstraction reduction scenarios with SME within the business and used experience gained from delivery of sustainability reductions programme between 2020 - 2025 to inform this scenario. Preliminary ecological assessments are carried out for these types of work and ecologist from our Biodiversity team and supply chain work closely with Capital Delivery to ensure biodiversity requirements are met. Experience from this work has been used to inform our assessment of the likely impact on these scenarios on this component of the LTDS. The environmental response from the implementation of abstraction reductions through 2015 - 2025 is being monitoring as part of our environmental monitoring programme. This information is being used to assess benefits and inform our strategy of location and volume of future reductions, alongside requirements under WFD and WRMP guidance. The response of abstraction reduction on chalk stream habitats and species is also being assessed through ecological surveys.
Extent of impact	There is an increased risk of the spread of INNS if not properly managed and mitigated, with the potential to introduce new species to our supply area through new raw water transfers or where potential conjunctive recreational use of new reservoirs for example occurs. The first SRO the Grand Union Canal scheme is included in our dWRMP from 2032 and therefore falls within the timeframe of this strategy. The associated implementation project for this SRO (and others) will be designed to mitigate any risk from INNS and also ensure BNG requirements are met.

Justification & Evidence	Under a high abstraction reduction scenario, potential increased baseflow in chalk streams benefitting from abstraction reductions could lead to improved fish passage, flows sustaining habitats and associated ecology, reconnected floodplains and improved chalk stream health. This would help sustain greater diversity of ecology and would increase biodiversity resilience in droughts. As we reduce the number of chalk groundwater catchments we abstract from, this could lead to the reduction in investment into nature-based solutions where we no longer have a requirement to implement mitigation measures later in the LTDS life cycle. This scenario would also reduce requirements to manage INNS within our landholdings which would reduce investments into managing INNS. This strategy needs will be aligned with any future land strategy regarding land disposals at sites which are no longer required for operational purposes due for example to the cessation of abstraction due to sustainability reductions. This will lead to an increased requirement of delivering a 10% biodiversity net gain under planning requirements. In this case, increased biodiversity investment would be required. We are unable to quantify these impacts therefore have not been able to produce an alternative pathway for these scenarios. The pace and scale of delivering the Environmental Destination in our region across the life of the LTDS will be monitored through the WRMP and will inform the development of our WINEP programme and associated biodiversity investments each AMP
Ongoing monitoring	We are surveying our landholdings to ensure we have baseline assessment from which we can monitor delivery and progress against our biodiversity strategy. This information will be used to inform future AMP requirements. Monitoring will include but not limited to: • Ecological surveys – habitats and species • Tree surveys • INNS surveys (Aquatic and terrestrial) • Entrainment of fish and eel fry at our surface water intakes

1.2 WINEP - Drinking Water Protected Areas (Schemes)

Table 5: Climate change RCP 8.5 and 2.6 scenarios:

Nature of impact	Higher temperatures and erratic, intense rainfall will heighten raw water deterioration risks. Greater rainfall intensity will erode agricultural soils into water, escalating nutrient, pesticide, and microbiological risks. Warmer temperatures and increased nutrients will encourage eutrophication and algal blooms, impacting aquatic life and water quality. Urban areas will also face heightened runoff, road runoff pollutants, storm overflow risks, and associated nutrient/microbiological concerns.
Method of testing	We have examined existing reports to understand the potential impacts of climate change on this strategy along with informed expert thinking. The benign and adverse scenario was assessed and determined through a risk-based review of the challenges posed by climate change detailed in our 2021 Climate Change Adaptation report. Our climate change risk assessment has been informed by key infrastructure risks set out in the UK's national climate change risk assessment (CCRA3) that are relevant to our business. We mapped the risks in our Adaptation Report and the associated Addendum report, and we have used this information to test this strategy against these risks.
Extent of impact	We have considered the extent of the impacts identified in our Climate Change Adaptation Report 2021. Treatment requirements for our sources are driven by the raw water quality. Changes in rainfall and temperature patterns could affect surface and groundwater raw water quality in myriad ways, making it difficult to determine the overall impact of climate change on treatment needs. Potential impacts include wetter winters and flood events leading to increased nutrient and pesticide runoff resulting in changes to nitrate concentrations and the mobilisation of contaminants in groundwater sources. Conversely, wetter winters could lead to greater dilution of pollutants in aquifers or increased urban runoff introducing heavy metals and fuel contaminants into watercourses or increased Combined Sewage Overflows (CSO) affecting the quality of surface water sources. Extreme rainfall following a dry period can result in a 'first flush' effects with high concentrations of nutrients and pollutants entering surface and groundwater sources. Flooding can lead directly to contamination. Sea level rise potentially leading to saline intrusion at coastal sources. We are already seeing some of these risks occurring across our region. For example, in the water we abstract from the River Thames we have observed higher levels of suspended solids and pollutants from land in the catchment, and also the effects of saline intrusion on our coastal sources in our Southeast region. Increased erosion, nutrients and road

	runoff is leading to pollution of rivers and in particular our precious chalk streams. Climate change will impact existing risks to raw water quality including those associated with changes in groundwater levels.
Justification & Evidence	In our Climate Change Adaptation Report (2021) and associated appendices we considered the key risks to the business from the effects of climate change and also the interdependencies between risks. Over time, we believe that under the 8.5 climate change scenario, costs of investments in mitigation measures would increase. This is due to degradation of agricultural and amenity land, decreased effectiveness of existing measures over time, higher temperatures, more intense rainfall increasing run-off risks, increased competition and price for raw water imports, reduced availability of ground and surface water due to more frequent droughts, increased outages due to flooding of assets and changes to raw water quality. Although we are unable to calculate the exact impacts that these risks will have, we are able to monitor key metrics to ensure they do not reach the designated thresholds. We aim to create more resilient catchments to the climate change impacts described above, which are important for long term sustainability of our catchments for water resources, water quality, food production and ecology, to protect important habitats for future generations and limit loss of wildlife. Changes in seasonal temperature and rainfall patterns are likely to favour pests and diseases which thrive in a warm and humid environment. An increase in pests and diseases will have a detrimental impact on agriculture, threatening both food and cover crops. Cover crops are beneficial for groundwater as they help to retain excess nitrate and reduce leaching. With reduced cover crops due to increased pests and diseases, a greater amount of nitrate and other pollutants is likely to leach into aquifers, resulting in a deterioration of raw water quality and posing a risk to water resource availability in our region. Increased pest pressure on crops may lead to new herbicides being used which may pose water quality risks. Pests and diseases will play a large role in the loss of critical ecosystem services. For example, Ash Dieback, a fungus which can thrive in certain seasons, is expected to kill 80% of ash trees across the UK. The loss of trees is significant because they provide shade, moderate temperature, promote soil stability, reduce runoff, favour infiltration and lock-in carbon (CCAR, 2021).
Ongoing monitoring	We will monitor this through a combination of: • Catchment and abstraction sampling alongside remote sensing and satellite imagery • Real time telemetry for key contaminant risks, temperature, rainfall and proxy measures such as turbidity • Natural capital baseline assessments and benefits monitoring of C&NbS investments • Pesticide and nutrient risk modelling

Table 6: Faster and slower technology scenarios:

Nature of impact	The roll out of the specific parameters set out in the faster and slower technology scenario within the LTDS guidance is considered unlikely to have a significant transformative effect on this strategy. We are deploying techniques such as remote sensing to assist catchment land use assessments and risks, but we are not expecting advances in this technology to result in a material change to our approach. Advances in wider agricultural technology and techniques e.g. precision farming, new chemical treatments, application methods and monitoring could have a positive or negative impact on this strategy and we with therefore monitor this through 2025 - 2030 and beyond, using the latest best evidence to support how we adapt our approach. The increased risks of raw water deterioration highlighted in the climate change scenario highlights the additional risks that will need to be effectively monitored and mitigated through technological enhancements. Agile decision making and responses, both operationally and through catchment-based actions utilising technological advancements will support both preventative measures and real-time incident response. The impact if technological advancements cannot predict, monitor and mitigate risks will expose our assets to a greater risk during significant events.
Method of testing	We have examined the findings of our catchment investigations between 2015 - 2025, associated reports alongside reviewing our work with universities and catchment partners and engagement with organisations including UKWIR on advancements in technology. We have used this to understand how technology has changed over

	previous AMPs and within agricultural practices. This has been further supported and informed by expert thinking. We recognise that technology could significantly change the need or offset future costs, but we are unable to accurately define or quantify this impact at this time.
Extent of impact	Whilst it is inherently challenging to accurately forecast the extent of this impact, to reflect our approach to innovation and collaborative working, we have assumed that the guidance specific parameters will not have a material impact on this strategy. However, under a faster technology scenario this should provide more detailed and localised rainfall data and forecasting for example. This has the potential to provide new real-time datasets and intelligence to support farmers with spraying and application of crop protection products, which in turn could help reduce runoff and leaching of these components which impact raw water quality. This will also enable improved advice and guidance from us in the management for pollution risks to water. At the present time it is not possible to quantify this, but we have seen through our WINEP benefits to water quality from providing farmers with access to local weather stations. New innovative agricultural techniques and the wider uptake of regenerative agricultural practices will influence the extent of impact. Whilst there is likely to be a change driven by for example legislative requirements, new products on the market, changes in land use and improvements by the wastewater sector to address CSOs, it is not possible to quantify these impacts at this time. We will be monitoring the effects of these interventions to inform the strategy going forward but at this time we consider it would result in an expenditure change of less than £10m per AMP and therefore does not require an adaptive pathway.
Justification & Evidence	We have considered the slower technology scenario and although delays in the implementation of these technologies could result in further, or longer-term deterioration of water quality which would impact the raw water deterioration pathway, the core pathway is not sensitive to this scenario. However, increased availability of open source 'real time' monitoring data for water quality in the River Thames over the life cycle of the LTDS will be beneficial in improving decision making in the response to incidents operationally and the targeting of measures in-catchment to mitigate pollution risks. Conversely, if there is a delay in the adoption of, or the availability of such open-source data from third parties, e.g. water and sewerage companies, will result in a greater dependence on our own catchment sampling and abstraction monitoring to inform decision making. This would lead to us being more reactive events, whereas greater access to real time open-source data can improve proactive interventions and/or operational management at our abstractions.
Ongoing monitoring	We will monitor this through a combination of: • Collaborating within the industry (i.e. through UKWIR) to be aware of, and support development on technologies to manage risk. • Utilising remote sensing and satellite imagery technologies and associated advancements to improve response to risks and incidents. • Collaborate with academic institutions to support research, investment in and adoption technologies such as pollutant risk modelling, passive sampling. • Real time telemetry for key contaminant risks, temperature, rainfall, and proxy measures such as turbidity • Catchment sampling programmes and land use risks mapping.

Table 7: High and low demand scenarios:

Nature of impact	A high growth scenario and associated high demand for potable water will necessitate increased water production and greater reliance on surface water sources. Management and protection of the DrWPAs for our existing and newly developed (SRO) sources will be critical. This is directly linked to our Environmental Destination strategy to reduce our reliance on groundwater sources and support WFD requirements.

Method of testing	For our dWRMP24 we collaborated in a project on behalf of the WRSE and WRE water companies to update our population and housing forecasts. Considerable growth may result in changed land use within our catchments from rural to urban. We will update our DrWPA requirements as further information is available.
Extent of impact	The dWRMP24 housing forecast predicts a 30% increase in total number of properties by 2050, which may drive land use changes, such as increase in impermeable areas impacting recharge and runoff rates. Development of brownfield sites may also occur with associated groundwater quality risks. Our balance of risk may shift from agricultural to considerations around urban runoff pollution. We will look to quantify this as more information becomes available through local plans, working closely with local planning authorities to understand changing or additional risks.
Justification & Evidence	Under the high population growth scenarios, we assume that increased development activities in the DrWPA's will lead to increased risk of pollution impacts and, associated raw water deterioration for which this pathway would need to be adaptive to mitigate. We also assume under the high population scenario, there will be an increased likelihood and pace of developments of nationally critical infrastructure in the DrWPA, such as an expansion of Heathrow Airport. A change in land use from rural (agricultural land) to residential and development of brownfield sites has the potential to change the type, source, and nature of risks to DWPA from agriculturally based to more urban runoff risk.
Ongoing monitoring	The associated monitoring plan with this core pathway will identify the need for adaption in the use of C&NBS to mitigate any risks and achieve the ambition set out for this pathway. This would increase expenditure on C&NbS for future customers. This will be monitored through the strategic regional planning process and associated WRMP's developed through each AMP cycle, which in-turn will inform the development of the associated WINEP programmes. Monitoring of housing development and critical national infrastructure developments will be undertaken through our Environmental Strategy and Planning functions and direct engagement with Local Authorities, regulatory bodies and developers through the planning process.

Table 8: High and low abstraction reduction scenarios:

Nature of impact	Under the high abstraction reduction scenario included in our rdWRMP there will be an increase reliance on surface water including from potential new strategic resource options like the GUC or SERSO. This will require the designation of new DrWPA's for the new source waters. The change in the proportion of source water for public supply to a greater volume from surface waters will mean a change in risks both due to new catchment areas of the source waters but also through the criticality of these sites due to less reliance on chalk groundwater. Increasing volume and reliance on surface water from the River Thames resulting from the required sustainability reductions implemented across the life of the LTDS in order to meet our Environmental Destination strategy.
Method of testing	Abstraction reductions for environmental purposes are policy driven pressures. The extent of reductions is determined by the regulators in association with the water companies. The impact of Environmental Destination scenarios (high abstraction scenario based on the EA's "enhanced scenario" and the low abstraction reduction scenario based on the legal requirements and aligned with our rdWRMP low Environmental Destination) have been reviewed by relevant SME leads for associated impact on surface waters and hence DWPAs.
Extent of impact	It is not currently possible to quantify the impact of the high and low abstraction reduction scenarios but our adaptive planning pathway within the rdWRMP allows for robust assessment of new SROs and therefore the need for designation of new DWPA. We have a good understanding of the catchments which currently fall under DWPA through our work over 2015 - 2025 on WINEP and therefore the increased critically of protecting those surface water sources going forward.
Justification & Evidence	We have used information from our dWRMP24 Environmental Destination to assess the extent of impact, along with our experience gained through WINEP schemes between 2015 - 2025. Under the high abstraction reduction scenario, it is assumed that increased reliance on abstraction from surface water from the Thames and new SRO scheme will increase the criticality of DrWPA designation and measures to protect these. Therefore, this pathway would need to be adaptive in response. This could lead to increased investment in C&NbS to increase resilience of these abstractions. This will align with the change in supply base as set out in the rdWRMP.

Ongoing monitoring	The associated monitoring plan, DWSP risk assessments and WINEP investigations will identify the need for adaptation in the use of C&NbS to mitigate any risks and achieve the ambition set out for this pathway. This will be developed and agreed as part of each WINEP/AMP cycle. Under the high abstraction scenario, there is likely to be an expectation to increase the size and scale of C&NbS measures to ensure adequate protection of surface waters and maintain supplies to customers.

Table 9: Catchment care scenario:

wider scenario is 'Catchment Care', addressing the uncertainty of third-party engagement, collaboration, and partnership to reduce pollutants entering water within our catchments, increasing risks to raw water quality.

Nature of impact	Raw water sources in our regions have specific vulnerabilities to contamination, dependent upon land use in our catchments and the effective management of pollution sources such as wastewater and agricultural point and diffuse pollution. For example in our Central region where our Environmental Destination strategy will increase the proportion and criticality of water supplied from surface waters including the River Thames, alongside the need for designation of new DrWPA for the new SROs. We also have a number of pollution-vulnerable groundwater sources, which whilst not directly covered under this DrWPA strategy are potentially impacted and may be affected by the uncertainties of third-party collaboration to address these issues.
Method of testing	We have used information from historic pollution incidents and issues associated with historic contamination of land to inform this scenario with input from SME.
Extent of impact	As we own very little land within the surface water catchments of our sources, we must manage land use risks through engagement activities and opportunities to influence catchment partnerships. Competing land management pressures are likely to influence future scenarios and we will continue to pursue opportunities to incentivise best practices to mitigate risk through, for example, the use of Payment for Ecosystem service approaches.
Justification & Evidence	Our 'core' strategy to manage this risk is to adopt C&NbS first, partnering with land managers to minimise risk at the source and minimise the 'grey' treatment solutions required and associated base costs. Our strategy includes significant investment in catchment management to protect raw water and our innovative approaches have already proved effective in specific instances to date. However, the inherent reliance on the collaboration of external stakeholders and a dependence on effective regulatory enforcement of the Polluter Pays Principle represents a material risk to this strategy. Additionally, our catchment management activity cannot influence all potential sources of pollution e.g. those relating to wastewater. It is a plausible extreme that from 2030 collaboration of landowners and stakeholders does not continue in key locations, progressively increasing the risk of raw water deterioration and increasing the requirement of 'grey' treatment solutions. Similarly, other sources of pollution may emerge within catchments that are beyond the scope of catchment management activity we can deliver. We have therefore defined this 'little influence' as our 'low' scenario, 'strong influence' as the 'high' scenario, enabling the successful implementation of our catchment management strategy. If landowners and land managers are no longer willing to engage with or receive investment towards C&NBS interventions, we will return enhancement investment back to customers through Price Control Deliverables. We will continue to work closely with the EA through the WINEP engagement process through each AMP to identify aspects where pollution risks should be subject to regulatory enforcement under the Polluter Pays Principle and Farming Rules for Water. We will provide monitoring data and supporting evidence for enforcement action, and where appropriate, will support landowners and land managers to minimise the raw water deterioration risk, whilst ensuring that our customers are not paying for actions for third parties to achieve legal compliance. All measures that will be funded through this pathway will support third parties to meet good or best practice.

Ongoing monitoring	We recognise that there will be an impact, but it is not currently possible to quantify this and therefore we will monitor to inform the future strategy. This will include: • Changes in land use and land ownership/tenancy. • Planning applications through local planning authorities. • Catchment and abstraction sampling. • Real time telemetry for key contaminant risks, temperature, rainfall and proxy measures such as turbidity. • Remote sensing and satellite imagery. • Environment Agency Pollution Incident Notification Service (POLWARN) • Our pollution time of travel model for the River Thames • Thames Water's event duration monitoring (EDM) for storm overflows

1.3 Water Framework Directive

Table 10: Climate change RCP 8.5 and 2.6 scenarios:

Nature of impact	Climate change will lead to more frequent and more intense extreme weather events, including extreme rainfall events, heatwaves and storms. Climate change will also lead to higher average temperatures throughout the year but particularly during the summer. We will also experience more heatwaves. Changes in seasonal temperature and rainfall patterns are likely to favour pests and diseases which thrive in a warm and humid environment. Pests and diseases will play a large role in the loss of critical ecosystem services. Our dWRMP considers the impact of climate change on our resource base and therefore the risk to groundwater and surface water sources including SRs has been accounted for. Extreme weather events for example high temperatures have the potential to result in increased risk of outages and therefore new infrastructure and non-infrastructure assets required to deliver the abstraction reductions will need to be considered during design and construction. High groundwater levels may also result in the risk of boreholes going artesian causing groundwater flooding, or increased occurrence of groundwater emergence where abstraction is reduced due to a sustainability reduction which could result in damage to equipment or a loss of access to a key monitoring site. High and low flows alongside intense rainfall events will need to be considered in the design of river restoration/improvement projects to ensure there is no increased risk of flooding. However, the C&NbS programme provides the opportunity to make chalk stream habitats more resilient to extreme weather events, for example, through the creation of refuge areas, reconnecting floodplains and use of two stage channels.
Method of testing	We have built upon the work undertaken for our 2021 Climate Change Adaptation Report and expanded this assessment to include a wider number of risks and their interdependencies and the potential impacts of climate change on this strategy along with informed expert thinking.
Extent of impact	We have considered the extent of the impacts identified in our Climate Change Adaptation Report 2021 and the associated addendum report in detailing additional risks and considered these in the context of the reference scenarios of RCP 2.6 and 8.5. Our climate change risk assessment has been informed by key infrastructure risks set out in the UK's national climate change risk assessment (CCRA3) that are relevant to our business. Climate change risk R01, R02, R03, R04, R05, R06, R09, R010, R14, R15, R18, R20, R23-25 impact different elements of this strategy.
Justification & Evidence	To test the climate change scenario, we have undertaken a risk-based review of the challenges posed by climate change detailed in our 2021 Climate Change Adaptation report. This enabled us to identify the following risks to this pathway including increased demand for water due to higher temperatures and prolonged dry weather, increased asset failure due to extreme weather events, reduced availability, and changes to the quality of ground and surface water due to drought.

	We anticipate risks that would both impact the delivery outcome and inform the adaptive pathway under this scenario include: • An impact to water cycle, leading to increased need or pace of delivery of SRs and C&NbS schemes to adapt to/mitigate these risks. • SRs not achieving desired environment outcome and associated revisions to the Environmental Destination abstraction reduction volumes for our region. • Increased reliance on C&NbS alongside engineering infrastructure solutions to maintain security of supply from increasingly critical surface water sources. • Shortfalls in the supply/demand balance and a greater dependence on imports, which will increase as further SRs are implemented. • More intense rainfall resulting from climate change causing spikes in pollutants requiring C&NBS to mitigate these risks at the source. Under the 8.5 scenario, we are likely to see greater expenditure in asset protection measures, increased scale and pace of sustainability reductions and costs, increased costs of C&NbS (however, this could increase the amount of operational and embedded carbon impacting our Net Zero pathway
Ongoing monitoring	However, we will monitor all these aspects though a programme of groundwater, surface water and abstraction monitoring. This will take place alongside a natural capital baseline assessment of each stage of the development of each project and associated detailed design. If necessary, we will revisit the need for an adaptive pathway between 2030 - 2035. This monitoring programme will include: • Abstraction impact assessments (WINEP investigations) during each AMP cycle • River flow monitoring and ecological surveys • Local and regional groundwater levels (non-abstraction influenced) and local and regional rainfall data • Source performance assessments, including groundwater observation borehole level monitoring and river flow gauging • Water quality sampling (abstraction and catchment)

Table 11: Faster and slower technology scenarios:

Nature of impact	The roll out of the specific parameters set out in the faster and slower technology scenario within the LTDS guidance is considered unlikely to have a significant transformative effect on this strategy. The new wastewater approach by 2040 and availability of open access data will help to inform most programmes within the strategy including C&NBS, river restoration and the realisation of benefits to chalk stream ecology resulting from SRs.
Method of testing	We have considered the faster and slower technology scenarios on the effect on this strategy with SME and experience gained through delivery of our WINEP between 2015 - 2025.
Extent of impact	It is inherently difficult to forecast the extent of the impact of a slower or faster technology scenario on this strategy. We have considered through review by SMEs some wider benefits of innovation and technology.
Justification & Evidence	Slower adoption and roll out of technology, particularly delays in implementing a smart water supply network and full smart meter penetration, will lead to greater risks for the demand management element of our WRMP. This will delay the realisation of the benefits, particularly in reducing overall customer demand resulting in a greater dependency on other demand management measures included in our current dWRMP. This will then cause increased water usage over time, increasing the water deficit. This could have an impact on the pathway taken in the regional adaptive planning approach and associated WINEP WFD pathway. There are also uncertainties around the affordability and effectiveness of these technologies and whether the technological developments can occur at a pace to mitigate the impacts of the climate change scenario. Delays in the implementation of a new wastewater approach could result in an increase or delayed benefits for improving water quality resulting in reduced resilience for alternative supplies. Slower adoption of wastewater technologies could also limit water recycling opportunities and their adoption/inclusion under the WRMP ultimately impacting on the required pace of delivery for this pathway. Under the slower technology scenario, we are likely to see greater expenditure in asset protection measures, increased scale and pace of sustainability reductions and associated costs, increased costs to import water and costs of delivering C&NBS. This could also increase the amount of operational and embedded carbon impacting our Net Zero pathway). However, we will ensure we monitor technological developments over the coming AMP. If necessary, we will revisit the need for an adaptive pathway between 2030 - 2035.
Ongoing monitoring	We will monitor this through a combination of: • Collaborating within the industry (i.e. through UKWIR) to be aware of, and support development on technologies to manage risk. • Utilising remote sensing and satellite imagery technologies and associated advancements to improve response to risks and incidents. • Collaborate with academic institutions to support research, investment in and adoption technologies such as pollutant risk modelling and passive sampling. • Real time telemetry for key contaminant risks, temperature, rainfall, and proxy measures such as turbidity.

Table 12: High and low demand scenarios:

Nature of impact	The high and low demand scenarios will impact the pace and scale of the abstraction reductions in the short to medium term. These reference scenarios are unlikely to influence the other areas of strategy e.g. river restoration, chalk stream flagship project and C&NbSs.
Method of testing	This scenario has been assessed by SME and informed by dWRMP.
Extent of impact	The scale, location and pace of sustainability reduction programme will be informed by our WRMP adaptive pathways and the outcome of WINEP investigations to ensure reductions are made in the locations that are likely to most benefit the environment.
Justification & Evidence	Increased supply/demand deficit will result in further need for replacement water. This could be impacted both seasonally and over the long term, leading to uncertainties around meeting the long-term Environmental Destination programme. This would result in an impact to the scale and pace on implementing SRs and supporting C&NbS. Under the high demand scenario there could be an increased need for river augmentation schemes to mitigate abstraction impacts and to improve flows in chalk streams determined through the WINEP investigations carried out each AMP through this pathway. There would be a potential delay in the implementation of SRs and a need for increase short-term mitigation measures.
Ongoing monitoring	We will continue to monitor population growth over the coming AMP as well as the Environmental Flow Indicators (EFIs), to ensure that abstraction or flow regulation is not starting to have an undesirable impact on river habitats or species. We will re-evaluate the need for an adaptive pathway between 2030 - 2035.

Table 13: High and low abstraction reduction scenarios:

Nature of impact	The sustainability reductions programme element of this strategy is directly linked to the low and high abstraction reductions scenarios. This will in turn influence the location of groundwater sources that will require protection through catchment initiatives, and we will focus our programme to ensure the protection of the sources which remain following abstraction reductions. We will also align our C&NbS, including river restoration programme, to focus on those catchments where we have made abstraction reductions or where we continue to abstract to help mitigate the residual impact of abstraction on the environment.
Method of testing	Review of the high and low abstraction reduction scenarios with sensitivity analysis of SR programme costs at high and low abstraction reduction levels, assuming a consistent unit cost for all abstraction reductions based on actual costs between 2020 - 2025 and design costs for the 2025 - 2030 programme.
Extent of impact	The high and low abstraction scenarios will directly influence the SR programme in terms of location, volume and pace of delivery, deviating from 2030 onwards. The low scenario (to which our core pathway has been designed) includes 180 Ml/d reductions from 2030-2050, with the high scenario delivering 270 Ml/d. Given the consistent unit costs assumption, the expected variance is proportional, totalling £292m across the 25-year period.
Justification & Evidence	From 2030 onwards, we have costed sustainability reductions based upon average costs per Ml/d of abstraction reduction across the 2020 - 2025 and 2025 - 2030 programmes. This approach has been taken as exact locations of these abstraction reductions and the associated requirements of the schemes is less clear at present. However, the 2020 - 2025 and 2025 - 2030 programmes are likely to be a representative basket of schemes given the comparability in distances and volumes of water to be moved. The average capex unit cost across this period is £3.18m. The total deviation between the high and low extremes of the scenario across the period is 91ML/d.

	Low scenario (Ml/d)	**High scenario** (Ml/d)
2025 - 2030	21.19	21.19
2030 - 2035	44.76	57.68
2035 - 2040	39.68	58.58
2040 - 2045	47.02	59.92
2045 - 2050	48.00	94.33

Decision & Trigger Points	The decision to deviate from the Core Pathway onto the high abstraction reduction scenario pathway will be triggered by the results of investigations and in consultation with the Environment Agency in advance of the PR29 business plan.
Relative Likelihood	10-25%. The likelihood of each pathway is uncertain as it is based on policy driven work.

Monitoring the alternative pathway	We have an extensive environmental monitoring network and will continue to utilise this and ensure it is focused in the areas of interest. We will also look to work with catchment partners and citizen science to achieve the best coverage of our catchments. This monitoring will be used to inform the strategy going forward. We will monitor this through a combination of but not limited to: • Groundwater, river and lake levels through data loggers and telemetry • Water quality monitoring through spot sampling and continuous monitoring • Ecological surveys (inc. macroinvertebrates, macrophytes, fish) • Working with catchment partners, river groups and citizen science Backward Looking (Historic) Monitoring: WINEP Investigation Delivery - Reported annually via the WRMP annual return. Used to generate monitoring data and support modelling for the forward-looking indicators. Forward looking (forecasts): Required level of abstraction reduction, by AMP (feeds into the definition of 'sustainable' abstraction), Quantity of flow increase in River Colne, Lee and Ivel and benefit this has on downstream Deployable Output.: We will report on the outcomes of the two indicators as part of the WRMP planning process every 5 years but will hold an update meeting with stakeholders at least once a year to share ongoing findings.

2. Net Zero

Table 14: Climate change RCP 8.5 and 2.6 scenarios:

Nature of impact	Climate change is likely to have an indirect impact on our Net Zero pathway. A high climate change scenario will increase demand for water which in turn could increase both operational and embedded emissions. Potentially we would need to use more chemicals and energy to treat and pump more water to customers. Additionally, we may need to bring forward the timing of our infrastructure interventions to meet demand, following an alternative pathway outlined in the WRMP. A high climate change scenario is likely to also have an impact on our WINEP programme with the climate alternating the nature of the habitat improvement and river restoration projects we deliver. This has the potential to affect how much carbon can be sequestered by these projects, although there is significant uncertainty as to the impact this could have. To ensure the business remains resilience to climate risks greater investment in our infrastructure to mitigate increasing climate risks may be required in a high climate scenario, this similarly has the potentially to increase embedded emissions with construction work required to future proof assets.
Method of testing	The benign and adverse scenario was assessed and determined during an internal workshop with the relevant SME lead. A qualitative assessment was made of the impact of different climate change scenarios.
Extent of impact	Given the uncertainty and complexity of climate change a quantification of the extent of impact has not been undertaken, however the impact is considered to be below £10m within each 5-year planning period.
Justification & Evidence	Our draft WRMP has identified that an adverse climate change scenario is likely to increase demand for water across our supply area and would require accelerated investment into resilience measures to manage our network to meet this increased demand and remain ensure we remain resilient to increased climate risks. At present the impact of following an alternative WRMP pathway on our Net Zero plan is difficult to quantify. It is likely that the nature of our activities to deliver low carbon infrastructure would remain the same but could require some increased investment. With similar activities required to address a high climate change scenario to the benign scenario an alternative pathway is not considered appropriate.
Ongoing monitoring	The impact of climate change on Net Zero will be monitored through future updates to the WRMP and the WINEP where the impacts of future climate change can be assessed. As we learn more through 2025 - 2030 and onwards about the costs to deliver low carbon infrastructure, we can apply this to our investments forecast and better understand how our investment profile may need to change to manage the impact of a high climate change scenario.

Table 15: Slower and faster technology scenarios:

Nature of impact	Technology is likely to have a direct impact on our Net Zero pathway. Technology has the potential to enable the faster delivery of carbon reduction and/or delivery of the same trajectory at a lower cost. The two most significant aspects of technology development for our Net Zero pathway are low-emissions fleet and low-carbon construction. Our core pathway sits in between the faster and slower technology scenarios, with enhancement spend aligned to the planning assumptions of: - Having low emissions alternative vehicles for vans and HGVs available by 2035, - Whole life costs of low carbon construction equal that of traditional construction by 2045 A faster technology scenario would reduce cost or accelerate carbon reductions on our pathway for Net Zero, with the opportunity to accelerate transition to low carbon solutions such as low emissions HGVs and low carbon construction materials at lower cost or earlier in the period. By contrast the slower scenario would delay delivery or increase costs.
Method of testing	Using the planning assumptions, we developed our core pathway to ensure it represented the best value delivery of our Net Zero ambitions. We then undertook the same economic analysis to identify the best value pathways for both the faster and slower extremes of the technology scenario.
Extent of impact	We have found that, while the timing and level of investment could vary, a slower technology scenario would result in a significant enough increase in investment to necessitate an alternative pathway being followed from 2030 onwards.
Justification & Evidence	We have undertaken green book base economic assessment of pathways for each of the plausible extremes of this scenario to understand the variance to our core pathway and ensure 2025-2030 investments remain low regrets. Within these assessments we have included key assumptions from the UK Government Net Zero Strategy, such as: - Planning for decarbonised electricity power system by 2035. - Increasing investment in hydrogen fuel technology
Decision & Trigger Point	We have set these as 2030. This is required as we have identified that our core alternative pathway deviates from 2030 onwards. The business planning cycle will trigger a decision as we review the forecast costs to deliver low carbon infrastructure and understand which pathway that we are likely to be following.
Relative Likelihood	10-25%. The fast technology pathway is based on significant action across government and many different sectors and industry, it is therefore highly uncertain. Our approach to Net Zero is such that we can monitor the prevalence of low carbon technologies and energy between 2025 – 2030, before taking a decision on which pathway we are likely to be following.
Monitoring the alternative pathway	As one of our 10 innovation priorities, investigating and trialling new technologies to achieving Net Zero will be central to our innovation efforts. We will monitor how relevant technologies are brought forward in several ways. Through our procurement activities, we will be regularly engaging with suppliers to assess the availability of low emissions vehicles and low carbon construction options. We will also use updates provided by the Climate Change Committee (CCC) to provide horizon scanning of longer-term trends in Net Zero related technology. Updates by UK government of the UK grid emissions factors provides a good indication of the current trends in the decarbonisation of the electricity grid and reports provided by the CCC again provide the longer-term view, to which we can adapt our planning.

Table 16: High and low demand scenarios:

Nature of impact	High and Low Demand scenarios could have an indirect impact on the Net Zero pathways. Changes in demand impact both the operational emissions through energy and chemicals used to treat each unit of water and embedded emissions resulting from additional asset interventions to meet increased demand. Whilst we expect to address much this within base costs or in the way we deliver other enhancement activity, the direct costs of our Net Zero pathway may increase in a high demand scenario, with our core pathway set at the mid-point of the two plausible extremes.
Method of testing	The high and low demand scenario was assessed and determined during an internal workshop with the relevant SME lead. A qualitative assessment was made of the impact of different climate change scenarios.
Extent of impact	The impact is considered to be below £10m within each 5-year planning period and therefore an alternative pathway has not been developed.
Justification & Evidence	The impact of demand changes is accounted for within our WRMP, in which an adaptive pathway for the high demand scenario is included within our LTDS. Detailed costings of these pathways have been developed and there is no rationale for a differing assumption for the cost of using low carbon construction materials in this pathway versus those within this core pathway.
Ongoing monitoring	Our annual review of the WRMP will inform whether any material changes to capital investments will require revision of our Net Zero pathway.

Table 17: High and low abstraction reduction scenarios:

Nature of impact	Abstraction reduction scenarios indirectly impact our Net Zero pathway, as the adaptive pathways required in other strategies change the pathway needed to achieve Net Zero. For example, as our WRMP and WINEP pathways change our treatment and network infrastructure more significantly to achieve the high abstraction reduction scenarios, both operational and embedded emissions will increase without additional investment in our Net Zero pathway.
Method of testing	The high and low abstraction scenario was assessed and determined during an internal workshop with the relevant SME lead. A qualitative assessment was made of the impact of different climate change scenarios.
Extent of impact	The impact is considered to be below £10m within each 5-year planning period and therefore an alternative pathway has not been developed.
Justification & Evidence	The impact of abstraction reduction changes is accounted for within our WRMP, in which an adaptive pathway for the high demand scenario is included within our LTDS. Detailed costings of these pathways have been developed and there is no rationale for a differing assumption for the cost of using low carbon construction materials in this pathway versus those within this core pathway.
Ongoing monitoring	As our Net Zero pathways is indirectly impacted, monitoring is bet undertaken by understand how the business will respond to Environmental Destination changes, such as updated to the WRMP.

3. Lead

Table 18: Climate change RCP 8.5 and 2.6 scenarios:

Nature of impact	Climate change is not anticipated to impact upon the risk posed by lead within the RCP plausible extremes across the 25-year period. Climate change may marginally increase water temperatures within the network and therefore plumbosolvency, increasing the risk posed by lead pipes, but this can be managed through existing dosing and would not require an alternative pathway. Climate changes also poses a risk to increased bursts within our network through extreme weather driven ground movement, which could increase the requirement for replacement of lead supply pipes due to increasingly frequent bursts.
Method of testing	Desktop research, expert judgement and analysis of historic pipe repair and lead sampling data.
Extent of impact	Analysis indicates that the degree of variation in water temperature within lead pipes caused by climate change will have little impact on the overall risk faced by customers. Similarly, climate change driven ground movement will not materially increase burst rate, given their inherent flexibility compared to other more vulnerable materials such as cast iron. No material impact is therefore forecast on our core pathway at either plausible extreme of climate change.
Justification & Evidence	The UKCP18 guidance shows that within all of the representative concentration pathways there will be an increase in air temperature of between 1.6 and 4.3 degrees Celsius by 2081-2100. Affinity Water sources its water from both groundwater abstraction and river abstraction. From a published article in the Quarterly Journal of Engineering Geology and Hydrogeology, the Chalk groundwater temperature is generally in the range of 11-12 0C. The impacts of climate change on Chalk groundwater temperature are unknown but the catchment urbanisation is likely to contribute to an increase in the baseline groundwater temperature as detailed in the same paper. A paper published by the British Geological Survey and the UK Groundwater Forum (British Geological Survey, IPR/47–4) suggests that the effect of climate change on groundwater resources depends upon any change in the volume and distribution of infiltration. It is stated that: "If drier warmer summers lead to the seasonal deficits in the moisture content of soils extending into the autumn, the winter recharge season for aquifers would be shortened. This could be compensated, at least to some extent, by an increase in winter rainfall. Lower rainfall in the spring would have an effect on groundwater levels, spring flows and the volume of base flow in rivers during the subsequent summer. Aquifers are recharged more effectively by prolonged steady rain, which continues into the spring, rather than short periods of intense rainfall. An important outcome of climate change is likely to be that groundwater storage will assume increasing importance". In the abstract from the American Geophysical Union, Morrill, J. C. et al conducted analysis on the relationship between air temperature and stream temperature. Within the abstract they found that 'Only a few streams display a linear 1:1 air/water temperature trend. The majority of streams instead show an increase in water temperature of about

	0.6 to 0.8 degrees for every 1-degree increase in air temperature.' We predict, as a result of this literature review, that climate change will likely increase the temperatures of the surface water at the river abstraction sources. The relationship between an increase in water temperature and plumbosolvency was analysed by J. H. Colling et Al. In the analysis, it was found that the increase in temperature caused an increase in lead concentration in both the high plumbosolvency trials and low plumbosolvency trials, where both sets of trials did not have phosphate dosing. It was found however that "the phosphate-dosed high plumbosolvency is different, showing little temperature dependence, and apparently a small decrease in lead level with increasing temperature"8. The evidence from the literature review above, that the increase in air temperature from climate change will increase the temperatures of our groundwater and river sources, which could lead to an increase in lead concentrations where the water is not treated with phosphates. Our historic leakage repair data show no indication that extreme weather events of the type expected to increase in frequency due to climate change have little impact on the burst rates of lead pipes.
Ongoing monitoring	We will continue to monitor lead pipe related bursts (repairs) and water temperature within our network. Should we observe significant shift in either, beyond the forecast ranges tested here, we will revisit our Lead Strategy, revised on a 5-yearly basis.

Table 19: Slow and faster technology scenarios:

Nature of impact	With the short-term focus of our strategy being to drive down unit costs within the first 5 years of the period, the pace of technology development is a key consideration for our lead strategy. Technology developments may drive the unit cost down further via improvements to or efficiencies within: • Lead pipe identification tools. • No-dig replacement solutions. • Customer engagement and appointment management tools. Dependent upon the degree, achieving efficiencies is unit cost shifts the optimal phasing of work over the 25-year period to being delivered later. Therefore, a fast technology scenario that achieves greater improvement in the early parts of the 25-year period may drive higher replacement rates in the 2030-2040 period. Conversely, as slow technology scenario that achieve more gradual but sustained improvement may drive us towards a higher replacement rate in the 2040-2050 period.
Method of testing	NPV economic assessment using varying assumptions of efficiency improvement.
Extent of impact	Whilst inherently challenging to accurately forecast, to reflect our initial focus on innovation and technology to drive down unit costs, we have assumed a frontier shift level of efficiency of at least 1.1% per year on the unit cost of supply and communication pipe replacement for the first 15 years, which we believe to be a 'mid-point' level of improvement between the plausible extremes, being at the upper end of frontier shift assumption to reflect specific focus in innovation in the short-term. This would result in a reduction in unit costs for full pipe replacements from £4,100 to £3,512 by 2040, in 2022/23 prices. We forecast the plausible extremes to be 0.6% per annum unit cost reduction across the full 25-year period for slow technology and 1.5% per annum for the first 15-years as fast technology scenario. At these extremes, NPV of the core pathway reduces 23% from core pathway for slow technology and increased 26% for fast technology. Neither of these plausible extremes materially impact the optimal phasing, however.
Justification & Evidence	During the current investment period, innovation in replacing lead comms and supply pipes has given us a detailed understanding of unit costs and highlighted opportunities technology development may offer, informing our assumptions on potential future efficiencies with further work across the industry.
Ongoing monitoring	The forecast unit cost will be monitored through innovation reports and industry data, informing a review of the phasing of our lead removal programme in the PR29 business plan.

Table 20: High and low demand scenarios:

Nature of impact	Increase in property development within the region will not materially impact the risk posed by lead, as the existing number of lead pipes will not be reduced, and new developments will not introduce additional lead comms or supply pipes. Decreased occupancy of properties with existing lead pipes will decrease the number of people exposed to the risk. Therefore, a decrease of occupancy rates will decrease the benefit of lead removal, whilst an increase will positively impact it.
Method of testing	Sensitivity analysis of NPVs to occupancy rates within our economic assessment.

Extent of impact	Across the plausible extremes of this scenario, occupancy is expected to reduce from 2.6 in 2025 to 2.43 in 2050 under the ONS population forecast and to 2.40 under the Local Planning forecasts. In testing the sensitivity of our economic analysis, the NPV of our core pathway is negligible, indicating no cause to revisit our ambition or pathway in light of either extreme of this scenario.
Justification & Evidence	Occupancy forecasts taken from local councils and unitary authority plans and ONS population and household projections. Green Book based economic analysis indicates no material change to the NPV of the pathway as benefits.
Ongoing monitoring	We will monitor occupancy levels and review our lead strategy accordingly within the PR29 business plan.

Table 21: High and low abstraction reductions scenarios:

Nature of impact	Abstraction reduction is not anticipated to impact upon the risk posed by lead within the high and low abstraction reduction scenarios across the 25-year period. Abstraction reduction may increase water temperature within lead pipes in our region, as we move from ground to surface water sources. This may marginally increase plumbosolvency, increasing the risk posed by lead pipes.
Method of testing	Modelling of lead solubility at increased temperature range.
Extent of impact	Analysis indicates that the degree of variation in water temperature within lead pipes caused by changing water sources, driven by abstraction reduction, may be up to 9°C. Under the high abstraction reduction scenario, this may apply to 30% of lead pipes in our region, and 20% under the low scenario. Analysis indicates that this has a low likelihood of materially changing lead solubility.
Justification & Evidence	Extent of temperature variability is shown in the tables below, averaged across all our water treatment works and water supply zones of each type of water, based on the most recent year of data which was representative of current normal conditions (see Table 22 and Table 23 below). Using the UKWIR 'Impact of dynamic system changes on customer acceptability' model we calculated that there was a low likelihood of change to lead solubility as a result of source water changes.
Ongoing monitoring	We will continually monitor water temperature within our network. Should we observe significant shift in either, beyond the forecast ranges tested here, we will revisit our Lead Strategy, revised on a 5-yearly basis in line with our regulatory planning cycle.

Table 22: Extent of temperature variability comparison between surface and groundwater sources

Sample Results from WTWs	Minimum (°C)	Average (°C)	Maximum (°C)
Groundwater (GW)	6	12	15
Surface water (SW)	2	14	24
Difference, when moving from GW to SW	-4	2	9

Table 23: Extent of temperature variability averaged across water supply zones

Sample Results from Customer Properties	Minimum (°C)	Average (°C)	Maximum (°C)
Groundwater (GW)	7	14	23
Surface water (SW)	6	15	25
Difference, when moving from GW to SW	-1	1	2

Table 24: Climate change RCP 8.5 and 2.6 scenarios:

Nature of impact	Climate Change will affect the temperature and therefore the Photo-evapotranspiration (PET) and Rainfall values in a given year. These varying climatic conditions can affect the supply of water in a region; therefore a climate change vulnerability assessment must be undertaken to determine the risk this common reference scenario presents. The assessment was undertaken regionally to provide a more accurate impact of the different Climate Change scenarios. The modelling of the impact is done through the use of Regional Climate Models, supported by Global Climate Models, derived from the United Kingdom Climate Impact Programme (UKCIP). This modelling was all done at RCP8.5 and using a scaling factor an impact was produced for RCP 2.6. A decrease in rainfall can affect the recharge rate of both Groundwater and Surface Water sources, however, the impact is more noticeable on Surface water resources.
Method of testing	LTDS have modelled the climate change impact in the same way at which WRSE have modelled the scenario. All runs have climate change impact modelled at RCP8.5, which has a combined DO reduction for Affinity Water of approximately 25 Ml/d at 2039/40. Using the WRSE scaling factor, this impact is mitigated to that of RCP 2.6. The overall impact on DO, from an RCP 2.6 climate change scenario, is approximately 12.5 Ml/d.
Extent of impact	As most of Affinity Water's abstracted deployable output (64%) is taken from Groundwater Sources, the impact of Climate Change is not as significant as other common reference scenarios. The total impact on DO of RCP 2.6 is approximately 11 Ml/d in 2039/40, whereas the impact of RCP 8.5 is approximately 27 Ml/d. The majority of this impact is in the Colne region (WRZ2).
Justification & Evidence	Under the adverse climate scenario, we will require additional operation expenditure using the GUC. This would occur between 2035 - 2040, 11 and 12. This will have a slight impact on customer bills but will not be significant due to the average incremental cost of GUC compared to the other options.
Decision & Trigger Points	The alternative pathway for the climate change scenario will begin in 2025/26 and will have a significant impact on DO. We have modelled this scenario for WRMP at a regional level to ensure commonality between companies. A selection of UKCIP products were used to create rainfall and PET scenarios for the region for each RCP. The core pathway for LTDS will use Climate Change Model 07 which is comparable to RCP 2.6. For RCP 8.5, the adverse scenario, we are using Climate Change Model 06. Although climate change does not have a significant impact on the available DO for most of the water resource zones (WRZ), there is serious impact on WRZ 2. The impact on DO under RCP 8.5 compared to RCP 2.6 is approximately double. The overall impact to total DO is therefore significant and requires an alternative pathway to allow for additional expenditure required to mitigate the extra DO reductions. The decision as to whether it will need to be followed will be based on if the scenario has reached the RCP 8.5 scenario, defined by the proportion of CO2 produced and characterised by warming factors. If it has reached this scenario, we will need to start implementing immediate intervention on a large scale. Details on the decision and trigger points and the rationale behind it can be found in table 4 below.
Relative Likelihood	10-25%. RCP2.6 is characterised by 1.5 degrees of warming, which is a very unlikely target due to current global actions. RCP 8.5 is just as unlikely as it is a 3.5 - 4 degrees warming future, which would occur through no intervention in climate change. The relative future is likely a median between the two RCP scenarios.
Monitoring the alternative pathway	Published warming and CO2 emissions trends - Review published data every 5 years to understand the likelihood of the different global emissions RCPs. Data on trends will tend to inform the forecasts. Updated temperature, rainfall and potential evapotranspiration (PET) forecasts and modelled impacts on Deployable Output and demand - Climate Change assumptions within the WRMP are based upon rainfall and PET data supplied by the UKCP analyses. These are fed by global and regional climate models that reflect future climate conditions. These ae periodically updated and the latest forecasts will be used every 5 years to inform the WRMP. Deployable Output risk will be updated at that time. For WRMP29 we will also use machine leaning tools to re-evaluate the likely impact on the dry year uplift on annual average demand.

Table 25: Faster and slower technology scenarios:

Nature of impact	The benign and adverse technology scenarios both deliver the same cumulative demand saving benefit over the 25-year planning period, however, under the Fast Technology common reference scenario, the overall benefit is reached sooner.

	Under the Slow Technology strategy, full smart metering implementation is reached in 2044/45, ten years later than in the Fast Strategy. This is the same for smart infrastructure. Although full smart metering implementation is delivered at a different rate, the number of smart meters delivered is the same. Therefore, the total cost and demand saving benefit over the planning period is the same, however, under the Fast scenario, the Totex and bill impact values are greater in the earlier AMPs.
Method of testing	There is no method of testing for technology scenarios. Due to the characteristics of the common reference scenario, fast or slow technology would have to be adopted at the beginning of the planning period to meet the timelines outlined in the LTDS guidance. To achieve smart infrastructure and full smart metering implementation by 2035, Affinity Water would have to install over 100,000 meters in the first two AMPs. There is no testing method due to the early Decision Date.
Extent of impact	As previously stated, the overall cost and Demand Saving benefit of the different scenarios is no different. However, the distribution of cost by AMP is significantly different. The profiles for Totex are laid out below in Table 6.
Justification & Evidence	For the LTDS core pathway, Fast Technology is being adopted which is characterised by full meter penetration by 2035 and smart networks implemented by 2035. This would see increased demand saving benefits between 2025 - 2035, with greater expenditure. Under the slow technology scenario, there will be significant impacts on delivery of outcomes due to less demand saving benefits in the early AMPs. There is significant pressure on the supply demand balance at the end of 2030. This would require investment to mitigate the deficit, however there are no feasible options to address this issue. Additional demand management strategies would be implemented to support slower metering and smart networks. This would increase customer bills in the near term due to pressure on the supply demand balance in the AMP and therefore increased expenditure. In later AMPs, the bill impact would be similar to the core pathway as demand management strategies peak.
Decision & Trigger Points	Slower technology is considered as the more adverse of the pathways, with a considerably shallower glide path for major demand management components e.g. Smart Metering. Therefore, the decision point is immediate, as it is necessary to determine the number of meters, smart infrastructure and leakage reduction delivered in the first two AMPs. The adverse scenario would be adopted in 2025/26 based on the demand requirements between 2025 - 2030 and whether the cost and bill impact of implementing a fast technology scenario would be too significant to adopt. The relative likelihood of the adverse scenario being adopted is very significant. To adopt a fast technology scenario, Affinity Water would have to implement 1.5 million smart meters by the end of 2035, whilst also engaging in more leakage reduction in the first two AMPs. This would increase the total expenditure by approximately £150 million between 2025 – 2035. While possible, this would have a disproportionate bill impact on customers, which does not align with the ambition of Affinity Water. In addition, the accelerated implementation of smart metering is not considered best value. Currently, our smart metering strategy uses fixed infrastructure but from 2030, the introduction of NB-IoT provides a more cost-effective method. Technology is not something we can measure throughout the plan to determine a different adaptive pathway based on the early branch point. It is a strategy that we adopt and then we monitor whether we are achieving our desired pathway of meeting our yearly totals for smart metering and leakage reduction benefit. Details on the decision and trigger points and the rationale behind it can be found in the table 7 below.
Relative Likelihood	10-25%. The Fast Technology scenario is an aggressive approach to demand management strategies and while it does deliver significant low-risk benefits in the early AMPs, it places a large bill impact on current customers for the benefit of future customers. Another issue with Fast Technology is that it can become more expensive than a gradual roll-out. This is due to the cost-benefit ratio of current technology against the ratio of future technology. A specific example is the hard infrastructure currently required to facilitate smart metering is significantly more expensive and less advanced than proposed future smart metering techniques using NB IoT.
Monitoring the alternative pathway	PCC, Distribution Input (DI), Leakage, benefits of demand management initiatives - Historic data (DI, PCC and Leakage) will be reported annually in the APR and used to track how our demand strategy implementation is progressing and how the activities we are conducting perform in practice. Our 'machine learning' analytical models that we have developed to quantify benefits from different activities will be used to quantify the benefits from individual programmes, which will be reported in the WRMP annual return. We will hold an annual demand management forum to share findings with stakeholders. Population forecasts, metering technologies, benefits of metering and demand management, deliverability of leakage targets - At 5-year intervals for the WRMP we will use the backward-looking data to update our assumptions to include more accurate demand savings in the regional WRMP modelling for future strategies. These will be integrated with market engagement and supply chain information to refine our future demand management strategies. Population forecasts and policies will be updated at this stage.

Table 26: Totex medium and fast demand profiles under the technology scenario

Component	Delivery Period			
Medium Demand Strategy (as appears in WRMP)	2025 - 2030	2030 - 2035	2035 - 2040	2040 - 2050
Total AMI meters(nr)*	376200.00	525500.00	522700.00	-
Newly metered properties (nr)*	71600.00	71800.00	71700.00	-
Replacement metered properties (nr)	304600.00	453700.00	451000.00	-
Total metering cost in period (£m)	92.40	158.10	161.50	
Fast Demand Strategy				
Total AMI meters(nr)*	638,950.00	785,450.00	-	-
Newly metered properties (nr)*	107,500.00	107,600.00	-	-
Replacement metered properties (nr)	531,450.00	677,850.00	-	-
Total metering cost in period (£m)	171.45	240.55	-	-

Table 27: Details and rationale of the decision and trigger points for the alternative pathway for the technology scenario

Point in time at which the alternative pathway deviates from the core or another alternative pathway	For the Technology common reference scenario, the branch point for an alternative pathway is 2025/26.
When the decision would need to be taken about whether the alternative pathway is followed (decision point)	This decision would need to be taken at the beginning of the planning period (2025/26) to properly model the different adaptive pathways.
Circumstances under which the alternative pathway would need to be followed (trigger point)	This scenario is adopted in the core pathway. This is a business decision, where the decision is based on whether Affinity prioritise high-risk, low-cost demand over low risk, high-cost infrastructure.
Why the specific alternative pathways and trigger/decision points have been chosen, including why the uncertainty identified needs to be alleviated through an alternative pathway	The alternative pathway is required as the strategy is significantly affected by the rollout of smart metering. Fast Technology delivers greater demand savings benefits in the earlier AMPs. This will change the investment timeline for larger scale infrastructure such as GUC and T2AT.
Why the date(s) associated with the trigger/decision point is important	2025/26 has been chosen as the decision point, as to deliver the full smart metering penetration by 2035, we will require all of the first two AMPs. (2025/26 - 2034/35).

Table 28: High and low demand scenarios:

Nature of impact	Housing Plan is the adverse scenario, with a DI of 1035 Ml/d by 2044/45, while ONS18 makes up the benign scenario, with a DI of 950 Ml/d by the same year. Under the High Demand scenario, we required approximately 85 Ml/d more by the end of the planning period.
Method of testing	Demand scenarios are characterised by population and properties numbers. For forecasting, Edge analytics have been procured to provide Housing Plan and ONS18 rebased growth forecasts. These provide the data for our Adverse and Benign scenarios.
Extent of impact	The total demand (Distribution Input) for ONS18, the benign scenario, is 957.58 Ml/d, whereas under the adverse scenario, Housing Plan, the total demand (Distribution Input) is 1058.93 Ml/d.

	This represents an increased requirement of 101.35 Ml/d, by 2049-50.
Justification & Evidence	The Demand common reference scenario is dependent on whether the population, property and occupancy values are more adverse in the ONS forecast or the Local Government H-Plan projections. In the case of Affinity Water, H-Plan is more adverse, therefore ONS growth has been used in the Core Pathway. Expenditure between 2025 - 2035 on the development of SESRO and the Lower Thames Transfer Phase 1 provides a "no regret" scenario, ensuring that if growth is more adverse (H-Plan) than the Core Pathway, there have been options developed to prevent a supply demand balance and ensure the plan still delivers on its ambition to provide a resilient, sustainable supply of water for Affinity Water's customers. The expenditure on these developments will have a great impact on customer bills from 2025 - 2040 and the operation of the SROs would increase bill impacts later in the AMPs above those in the core pathway. However, SESRO is required to meet the growing demand and development of the option is the best value for customers and the environment. Therefore, the strategy still delivers fairness between current and future customers.
Decision & Trigger Points	Demand is defined by the population of the region. The adverse scenario follows the H-Plan produced by local governments. The benign follows the ONS forecasts (currently ONS18 Rebased). Each are forecasts of population and properties, which are used to forecast demand. In accordance with the LTDS guidance, ONS18 is our benign scenario as the population and properties forecast is lower than that of the H-Plan. Currently the H-Plan is assumed to be most likely scenario, therefore we have modelled the best value plan to these projections. Under H Plan, we are expecting a population of approximately 5 million by 2049/50 (end of LTDS planning period). Under ONS18 Rebased, the population is approximately 4.2 million by 2049/50. This is a significant reduction in population and thus demand. An alternative pathway to demonstrate the difference in expenditure over the two demand scenarios will help inform necessary investments in early AMPs that will allow for the development of future options in an adverse scenario, while remaining cost effective. The trigger point for growth is 2035/36, in line with the WRMP Regional Planning trigger point. This is because population growth is a gradual measure driven by non-water resource sector factors. It will not be apparent which pathway is most likely to occur until deeper into the planning period. Judging by both the H-Plan and ONS18 Rebased forecasts, the difference in population, properties and occupancy is significant enough by 2035/36 that a decision can be made. Growth will be monitored through the edge population forecasts which are updated at each draft and final WRMP. The WRMP process continues to update population figures and remodel the demand for the company. PCC will be monitored as a part of the Annual Review (AR) and Price Review (PR) process, which provides data on how much water each person uses. Demand forecasts can be constructed from these data sets, which inform WRMP of the requirement for water supply and thus an estimate of total expenditure. Details on the decision and trigger points and the rationale behind it can be found in table 9 below.
Relative Likelihood	25-50%. Projecting likelihood of growth is very difficult as it is dependent on numerous social and economic factors. ONS18 rebased is generally considered by stakeholders and Ofwat to be more likely. However, all WRMPs are based upon Housing Plan which is required by the Water Resources Planning Guidance.
Monitoring the alternative pathway	PCC, Distribution Input (DI), Leakage, benefits of demand management initiatives - Historic data (DI, PCC and Leakage) will be reported annually in the APR and used track how our demand strategy implementation is progressing and how the activities we are conducting perform in practice. Our 'machine learning' analytical models that we have developed to quantify benefits from different activities will be used to quantify the benefits from individual programmes, which will be reported in the WRMP annual return. We will hold an annual demand management forum to share findings with stakeholders. Population forecasts, metering technologies, benefits of metering and demand management, deliverability of leakage targets - At 5-year intervals for the WRMP we will use the backward-looking data to update our assumptions to include more accurate demand savings in the regional WRMP modelling for future strategies. These will be integrated with market engagement and supply chain information to refine our future demand management strategies. Population forecasts and policies will be updated at this stage.

Table 29: High and low abstraction reduction scenarios:

Nature of impact	The profiles for Environmental Destination DO reduction scenario low and high are similar between 2025/26 and 2038/39. Under the high scenario, there are further DO reductions in 2039/40 that are not included in the low scenario. In the Long-Term Delivery Strategy, the High Abstraction scenario is based upon the Enhanced ambition in WRMP, and the Low Abstraction scenario is based upon the Company Alternative (BAU with Groundwater Impact factor of 0.3) ambition in WRMP.
Method of testing	Environmental Abstraction Reductions are policy driven pressures. The extent of reductions is determined by the regulators in association with the water companies.
Extent of impact	Under the benign scenario, Company Alternative, the total DO reduction impact after the 2045 - 2050 period ends, is 186.6 Ml/d. In the enhanced strategy, which constitutes the adverse scenario, the impact to available DO is a 292.39 Ml/d reduction.

	The difference between the adverse and benign scenario is 105.79 Ml/d.
Justification & Evidence	A high abstraction reduction scenario constitutes a 100 Ml/d greater DO reduction than the core pathway. If there is no alternative pathway developed for this common reference scenario, then there is likely a significant impact on delivery of outcomes and the supply and demand balance. Under this scenario, significant expenditure will be required between 2025 - 2040 for planning, developing and construction of the SROs. Expenditure would continue to be higher across the strategy due to higher operational costs based on utilisation of SROs. The expenditure is necessary to meet the statutory requirements of the supply and demand balance and is considered the best value option. Although customers' bills might rise slightly in the short-term, the strategy would unbalance bill impacts in favour of customers in later AMPs.
Decision & Trigger Points	Currently, there is a difference of approximately 100 Ml/d impact on our DO, between the high and low abstraction scenarios. This difference is the equivalent of the GUC scheme or the entire capacity of the Lower Thames Transfer Western Route. It is apparent from this significant difference between the two scenarios that an adaptive pathway is required to determine the additional expenditure that would be required in an adverse scenario. This will help to determine the necessary short-term investment required to allow for future options to be developed in an enhanced pathway. The trigger point is 2040, allowing plenty of time for water companies to agree upon and prepare for the DO reductions under a high abstraction reduction scenario. The trigger point has been set to this date to allow for the development of options to accommodate the decrease in available DO. Between the core and alternative pathway, there is no difference until the 2039/2040 split as DO reductions prior to this date occur at the same locations in the same volumes. Beyond this date, there are additional sites in the enhanced scenario that experience reductions, and this is what will trigger the decision of the alternative pathway. This common reference scenario is difficult to monitor as it is driven by the regulators of the WRMP who, alongside the water companies, determine the reduction in DO that is required. Currently the WRMP is modelled to Enhanced Environmental Destination. However, there is significant work being conducted between 2020 - 2030 to learn more about the consequences of abstraction reduction on the environment. This will help influence the decisions made between 2035 - 2040. If the adverse scenario is adopted, there will be a significant total expenditure increase, compared to the LTDS Core Programme. Details on the decision and trigger points and the rationale behind it can be found in table 11 below.
Relative Likelihood	10-25%. The likelihood of each pathway is uncertain as it is based on policy driven work.
Monitoring the alternative pathway	Backward Looking (Historic) Monitoring: WINEP Scheme Delivery - Reported annually via the WRMP annual return. Used to generate monitoring data and support modelling for the forward-looking indicators. Forward looking (forecasts): Required level of abstraction reduction, by AMP (feeds into the definition of 'sustainable' abstraction), Quantity of flow increase in River Colne, Lee and Ivel and benefit this has on downstream Deployable Output.: We will report on the outcomes of the two indicators as part of the WRMP planning process every 5 years but will hold an update meeting with stakeholders at least once a year to share ongoing findings. We will report on the outcomes of the two indicators as part of the WRMP planning process every 5 years but will hold an update meeting with stakeholders at least once a year to share ongoing findings.

5. Raw Water Deterioration

Table 30: Climate change RCP 8.5 and 2.6 scenarios:

Nature & extent of impact	We anticipate that the effects related to the RCP 2.6 scenario will be sufficiently covered within the core pathway approach but that the RCP 8.5 scenario could influence the core pathway approach. Testing the high climate scenario against our raw water deterioration core pathway, we considered that there may be several adverse impacts to raw water deterioration. These adverse impacts on the surface water in our region could include: - Wetter winters, which may lead to increase nutrient, pesticide, and urban run-off causing raw water deterioration. - Extreme rain following prolonged dry periods that could result in 'flush' effects whereby high concentrations and pollutants enter raw water abstraction sources. - Increased fluvial/pluvial and groundwater flooding events, leading to contamination events or mobilisation of contaminants already present in the soil. - Climate change led warming leading to drought or saline intrusion from rising sea levels.
Method of testing	The benign and adverse scenarios were assessed by a team of subject matter experts to determine the effect of scenarios on our projected core pathway for Climate Change. They considered the extent and scope of the changes associated with the high Climate Change scenario under RCP 8.5 and compared them to historic patterns of

	weather-related events and water quality. They made predictions about what plausible future effects could be based on climate change forecasts and concluded that there are four additional sites which could be affected under this scenario in addition to those in the Core Pathway. We also engaged hydrogeologist experts at Mott MacDonald to carry out research into likely climate change effects on the River Thames. They reviewed many years' worth of past river flow, river quality and weather data to establish the correlation of weather patterns and river flows with challenging raw water quality conditions. They then used climate change forecasts to predict how frequently these challenging raw water quality conditions were likely to occur in the future, and the extent of them (i.e. duration and frequency of algal blooms). We subsequently carried out an assessment of what impact those water quality changes could have on the treatment capability of the existing treatment processes at our surface water abstraction sites. This was based on historic data from online and grab sample monitoring as well as operator experience with the treatment works and how the treatment process plant capability is affected by different raw water quality envelopes. The resulting investment plan identified is efficient because it will only be triggered when the cumulative effect of climate change over the intervening period has sufficiently led to degradation of the raw water quality that it requires investment. We will continue to pursue all alternative approaches, including catchment management, blending and optimisation of existing treatment processes, to mitigate the risk and avoid the need for grey investment solutions.
Justification & Evidence	We tested the potential impact of these adverse outcomes through a piece of analysis with Mott MacDonald during which they explored correlation between historic extreme weather events and adverse impacts on River Thames water quality. The extent of their analysis is, verbatim: Increases in extreme rainfall driving spikes in sediments down the river network; Decreases in winter low flows leading to decreased nitrate dilution; and increases in spring/summer temperature and solar radiation, combined with decreasing river flows, driving changes in frequency and intensity of algal blooms. Their conclusions are, verbatim below: - the correlation found between high rainfall and maximum daily turbidity records in later summery/early autumn demonstrates the influence of extreme rainfall on the first flush effect. The overall trend reported in the UK towards wetter winters and more extreme rainfall could then mean increases in turbidity spikes. - Nitrate levels in the future are likely to increase during the winter months following a reduction in low flow conditions in the catchment; whereby the estimated flow threshold beyond which nitrate levels exceed the operating limit is likely to occur more often. By 2050 and in a high emission scenario, the blending limit for nitrate is likely (median value) to be exceeded on average 6 days/year. - cyanobacteria blooms in summer are likely to occur more often as a result of increases in temperature and solar radiation, as well as a decrease in river flows. The number of risk bloom days is likely (median value) to increase by 12% and 20% respectively for a low and a high emission scenario with a 10% and 15% increase respectively in the frequency of exceeding the operational limit. Resulting from this analysis, we concluded that there is a low likelihood deterioration of the River Thames water quality necessitating new treatment, but sufficiently plausible under the high climate change scenario to be included in the alternate pathway. There remains, however, significant uncertainty in quantifying the potential impacts of the high climate scenario and the timing (occurrence and frequency) of these events. This investment need will be adjusted and amended in future as further evidence is collected via our monitoring program. In terms of the impacts of climate change on our groundwater sources, we were better able to quantify and predict when these might occur. We have carried out at a detailed assessment of the adverse impacts on our groundwater sources as a result of the high and low Climate Change scenarios. The comparison of the Core Pathway and the adaptive pathway for high Climate Change scenario are presented in **Error! Reference source not found.** below. We have made these forecasts with a moderate degree of confidence.
Decision & Trigger Points	The decision to deviate from the Core Pathway onto the high Climate Change scenario pathway will be triggered by water quality data. Where the relevant parameter(s) is observed to be increasing and is projected to rise sufficiently to cause health or aesthetic impacts on consumers we will trigger development of mitigation options to prevent this occurrence. The projected AMP in which we expect the raw water to deteriorate sufficiently to require mitigation investment is given for each water treatment works in **Error! Reference source not found.** below in the 'High Climate Change Scenario' column. We do not believe it is a sensible approach to develop options and plan expensive interventions before there is demonstrable need for the investments. This is why we propose to continue to monitor water quality and take information from the WRMP as to what flows are required from the sources to influence when we trigger the decision to invest.
Relative Likelihood	10-25%. There is a high likelihood under the high Climate Change scenario that rising sea levels will result in contamination of the aquifer from which Kingsdown WTW abstracts water. This could occur any time from 2030 onwards. There is a high likelihood under the high Climate Change scenario, rising from moderate under Core Pathway, that climate change-related sea spray and storm surges at Denge will adversely affect the water quality in the gravel wells. There is a high likelihood that the high Climate Change scenario will result in need for nitrate treatment at Whitehall WTW, and the modelling indicated that peak concentrations may rise above PCV in 2040. There is a moderate likelihood that the high Climate Change scenario will result in the need for new solids removal treatment processes at Iver and Egham WTWs.

Monitoring the alternative pathway	The significant challenge associated with predicting and modelling the potential impacts of climate change effects, as well as their timing, highlights the criticality of our monitoring plan. While we do not propose to monitor the direct effects of climate change (e.g., air temperature or rainfall events) we will closely monitor the impact of these changes on raw water quality (e.g., frequency and duration of algal blooms) through real-time online monitoring on the River Thames upstream of our abstraction points and at the abstraction points themselves. We will monitor for a range of chemical and biological parameters. We will also assess water quality change through a comprehensive suite of grab samples analysed in our laboratory. As we go through the 25-year LTDS period, this monitoring plan will allow us to adapt our plans and ensure investment is focused on the most prevalent risks. As and when analytical methods are developed to quantify the impacts of climate change, and predict their frequency and occurrence, more accurately we will develop alternative pathways as appropriate to ensure the delivery of our ambition to maintain a safe and secure supply of water for our customers.

Table 32: Slower and faster technology scenarios:

Nature of impact	There is no impact on the Core Pathway of the High and Low Technology scenarios as none of the technologies mentioned within the definition of these scenarios are relevant to the water quality challenges expected and anticipated as part of raw water quality deterioration.
Method of testing	The benign and adverse scenarios were assessed by our internal subject matter experts and deemed to have no effect on our Core Pathway.
Extent of impact	There is no impact on the Core Pathway of the High and Low Technology scenarios as none of the technologies mentioned within the definition of these scenarios are relevant to the water quality challenges expected and anticipated as part of raw water quality deterioration.
Justification & Evidence	As there are no technologies included under the high and low Scenarios that are relevant to the water quality challenges expected and anticipated as part of raw water quality deterioration, there is no impact of these scenarios on the NPV of the Core Pathway.
Ongoing monitoring	We will continue to monitor developments in the technology space to enable our strategy of adopting a fast-follower approach to innovation of treatment processes.

Table 33: High and low demand scenarios:

Nature of impact	The potential impact of the High and Low Demand scenario on water quality deterioration could be an increase in use of imported water from neighbouring water companies, or increased use of the Grand Union Canal transfer. Both of these types of water are derived from surface water sources and therefore are fundamentally different in chemistry and aesthetic quality from water abstracted from local chalk groundwater sources. The adverse impacts on the water quality in our region could include increased average water age in the network and increased maximum age in certain hot spots where SRs have been delivered, which could lead to: • Decreasing residual chlorine residual in the network which is both a regulatory requirement and a partial protection against contamination in the network. • Increased production of disinfection by-products including tri-halo-methane compounds leading to customers complaints of tase and odour issues. • Decrease in customer satisfaction with their water as the taste and aesthetic experience will change with the shift in water source.
Method of testing	The benign and adverse scenarios were assessed by our internal subject matter experts and deemed to have no effect on our Core Pathway.
Extent of impact	We anticipate that high per capita demand may cause an increase in the surface water imports, consequently changing the blend of surface to groundwater ratio within the network. Although there may be some impact to the core pathway, the impact would not be material and thus an alternative pathway has not been developed.
Justification & Evidence	As there are no technologies included under the high and low Scenarios that are relevant to the water quality challenges expected and anticipated as part of raw water quality deterioration, there is no impact of these scenarios on the NPV of the Core Pathway.
Ongoing monitoring	The impact of wider distribution of surface-derived water is already being monitored, and interventions implemented such as the conditioning plant at Sundon Reservoir under construction between 2025 - 2030. We are developing hydraulic models to predict water age within our distribution network in future AMPs, as demand grows and elements of the Connect 2050 program are delivered. We will update these models each AMP to check that age of water (and consequent chlorine decay trends, bacteriological risks and disinfection by-product formation) is adequately managed. Where investment is identified and required this will be delivered as part of taking action and developing interventions if the risk is projected to increase. We will monitor chlorine decay trends, bacteriological risks and disinfection by-product formation within the network to ensure that there is no deterioration in level of service for customers and verify that this is successful by monitoring trends in customer contact data and C-Mex scores.

	There is no effect on the core pathway approach of the low demand scenario as it is unlikely to have any material impact on the deliverability of our Raw Water Deterioration programme.

Table 34: High and low abstraction reduction scenarios:

Nature of impact	It is possible that, in delivering fewer or more abstraction reductions, as per the High and Low scenarios, this could result in more of less migration of contamination within or between groundwater sources.
Method of testing	The benign and adverse scenarios were assessed by a team of subject matter experts to determine the effect of scenarios on our projected core pathway for Abstraction Reductions. They reviewed historic data trends indicating likely movement and dilution of contamination in aquifers. Our assessment was that there is no material change to the risk level between the abstraction reduction scenarios.
Extent of impact	We tested whether the high abstraction reduction scenario could influence the core pathway approach, with sufficient materiality for development of an alternative pathway. The high abstraction reduction scenario, or high environment scenario as set out in our dWRMP, involves reducing the amount of raw water abstracted from our groundwater sources, called sustainability reductions. Where those sources are affected by contamination, it is considered that the contamination is removed *via* the current treatment process causes the contaminant plume to remain *in situ*. When the planned sustainability reduction results in reduction or cessation of abstraction, this has the potential to release such contaminants to other downstream sources, negatively impacting the raw water quality of the downstream sources' abstraction. There are 11 sources potentially affected under the core pathway, and 12 under the high abstraction reduction scenario.
Justification & Evidence	**Error! Reference source not found.** below identifies which sources we believe may be affected by migrating contamination plumes as a result of sustainability reductions; there are 11 sources potentially affected under the core pathway, and 12 under the high abstraction reduction scenario. Some sites change designation to 'not applicable' under the high Abstraction Reductions scenario as they will themselves be turned off. Only two additional sources are picked up as being at risk under the high abstraction reduction scenario, and both of these are deemed to be 'very low' risk. This risk score has been given due to the high degree of dilution that is expected due to the distance between the contamination-affect source and the receptor source, indicating a very low likelihood of the risk materialising. The decision on our sustainability reductions programme involves negotiation with multiple regulators and customers before decisions can be made, therefore the extent of the reductions is at this point unknown. There will also be multiple iterations of this plan as it is developed over the coming AMPs as articulated within the decision and trigger points. There is no effect on the core pathway approach of the low abstraction reduction scenario as it is unlikely to have any material impact on the deliverability of our Raw Water Deterioration programme.
Ongoing monitoring	The decision to develop a high Abstraction Reduction scenario pathway will be triggered by water quality data. Where the relevant parameter(s) is observed to be increasing and is projected to rise sufficiently to cause health or aesthetic impacts on consumers we will trigger development of mitigation options to prevent this occurrence. The projected AMP in which we would expect to observe raw water to deterioration, were it to occur, is given for each water treatment works in the table above. We do not believe it is a sensible approach to develop options and plan expensive interventions before there is demonstrable need for the investments. This is why we propose to continue to monitor water quality and take information from the WRMP as to what flows are required from the sources to influence when we trigger the decision to invest.

Table 35 Core and high abstraction reduction scenario risk levels

Pumping Station (PS) to undergo SR	Downstream/ nearest PS at risk	Current Licence (Ml/d)		Asset Management Period for SR	Risk Level - core pathway	Risk Level – high SRs
		Average	Peak			
Berkhamsted	Hunton Bridge	10.59 (13.50)	10.59 (13.50)	8	Low	Low
Kings Walden	Digswell/ Fulling Mill	7.88	8.92	8	Very low	N/A
Kings Walden / Digswell / Fulling Mill	Musley Lane	4.32	5.05	8-11	N/A	Very low
Broomin Green	Molewood	1.82	1.82	10	Very low	Very low
Baldock Road	Bowring	7.96	7.96	9-10	High	High
	Fuller	7.96	7.96	9	Moderate	Moderate
Chipping	Thundridge	9.09	11.13	9	Low	N/A
Essendon	Waterhall/ Porthill	1.09/2.15	1.2/2.51	9	Moderate	Moderate
Newport	Uttlesford Bridge	13.66	13.62	10	Moderate	Moderate
Wheathampstead	Waterhall	1.09	1.36	11	Low	Low
Crescent Road	Waterhall	1.09	1.36	12	Very low	Very low
East Hyde	Waterhall	1.09	1.36	12	N/A	Very Low
Holywell	Brickett Wood	N/A	22	10	N/A	Very low
Temple End	Well Head	2.27	2.27	9-11	High	High

Table 36: Catchment Care scenario:

Nature & extent of impact	We anticipate that the catchment care wider scenario could influence the core pathway approach. Testing the Catchment Influence scenario against our raw water deterioration core pathway, we considered that there may be several adverse impacts to raw water deterioration. These adverse impacts could include: • Increasing concentration of nitrate, turbidity or spikes in cryptosporidium in the River Thames due to deterioration of farming and land-use practices. • Increasing concentration of herbicides, fungicides and pesticides in the River Thames due to poor application and farming practices. • Increasing concentration of personal care products, endocrine disruptors, ammonium, nitrate or phosphorous due to increased volumes of untreated sewage entering the River Thames via CSOs. Data from the River Thames in the 1980s shows that, before successful catchment activities were implemented, the nitrate concentration in the river averaged 35mg/l as NO3, and regularly peaked up to 50% higher than this. With the return of such a high background level of nitrate in the river, the bankside storage reservoirs that we currently use for blending peak nitrate concentrations will contain water with too high a concentration to enable this strategy in the future. We have included in our adaptive pathway for Catchment Care wider scenario the provision of ion-exchange treatment for nitrate removal at both Iver WTW and Egham WTW, two treatment works which abstract water directly from the River Thames. We forecast there is a low, but plausible, likelihood that this investment will be required under the adverse Catchment Care scenario. Assuming that the deterioration in success of the catchment management programme begins in 2030, the mitigation measures would likely be required by the 2045 - 2050 period. Using a standardised treatment unit cost of £1.5m per Ml of water treated, the investment cost is estimated as: • Iver WTW: £340m • Egham WTW: £210m

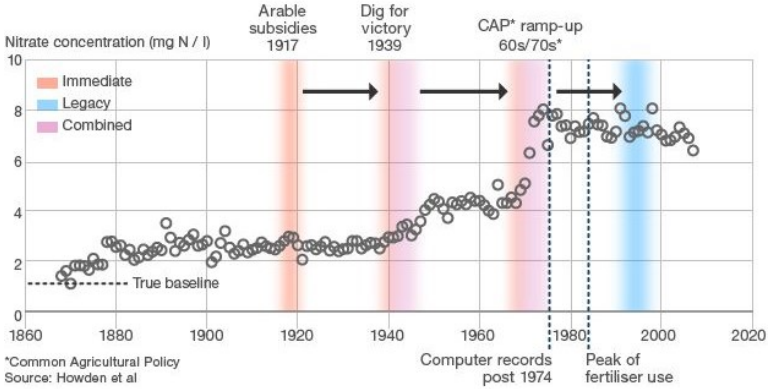
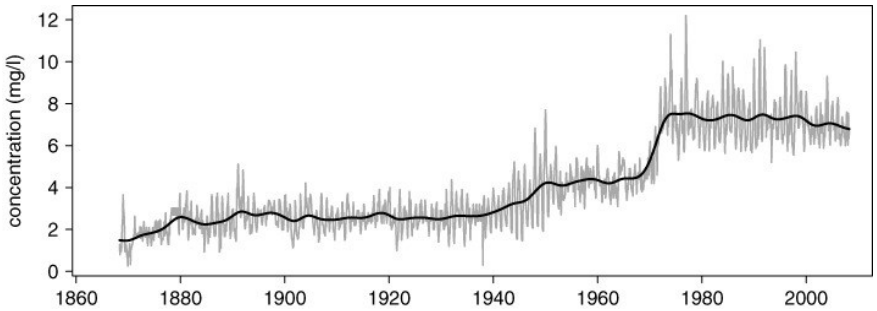
Method of testing	The benign and adverse scenarios were assessed by a team of subject matter experts to determine the effect of scenarios on our projected core pathway for Catchment Care. They reviewed historic patterns of weather-related events and peaks in water quality contaminant concentrations and made predictions about what plausible future effects could be. They identified that the most likely issues related to adverse Climate Care scenario would be increasing concentrations of nitrate and other chemicals associated with farming practices, which can loosely be termed pesticides. They also reviewed historic water quality data for nitrate on the River Thames prior to the implementation of stringent land-use and farming practices, which gave an indication of what a plausible future concentration of nitrate could return to if land-users disengage from our catchment management and improvement initiatives. The resulting investment plan is efficient because it will only be triggered when the cumulative effect of land-user disengagement over the intervening period has sufficiently led to degradation of the raw water quality that it requires investment. We will continue to pursue all alternative approaches to mitigate the risk and avoid the need for grey investment solutions.
Justification & Evidence	Data trends on the River Thames, as shown in the graph below taken from a BBC news article, show that nitrate concentrations increased suddenly between the 1970s as a result of the European Common Agricultural Policy and significant increase in agrochemicals in intensive farming. At this time the average concentrations rose as high as 8mg/l as N, or 35mg/l as NO3 Figure 13: How land policies to grow more food have polluted the River Thames  Further data, presented in the paper 'Nitrate concentrations and fluxes in the River Thames over 140 years (1868–2008): are increases irreversible?' shows that while the average nitrate concentration in the River Thames in the 1970s was around 8mg/l as N, the peaks were much higher than this – up to 12mg/l as N at times (53mg/l as NO3).

	Figure 14: Nitrate concentrations and fluxes in the River Thames over 140 years (1868–2008): Are increases irreversible?  If land use practices were to revert to pre-1980s norms, and land users were to disengage from collaboration with us to promote sustainable and river water quality friendly farming methods, it is possible that the concentration of nitrate in the River Thames could return to these levels. If this were the case, while we might be able to manage the average river concentration, we would not be able to manage the peak concentrations using the existing method of blending with alternate sources.
Decision & Trigger Points	The decision to deviate from the Core Pathway onto the high Catchment Care wider scenario pathway will be triggered by water quality data. Where the relevant parameter (Nitrate) is observed to be increasing and is projected to rise sufficiently to cause health or aesthetic impacts on consumers we will trigger development of mitigation options to mitigate the risk. The predicted AMP in which we expect the raw water to deteriorate sufficiently to require mitigation investment is towards the end of the LTDS period. Water quality changes resulting from land use practices have historically shown a lag effect between when application of fertiliser or farmer practices change and when the water quality change is measured in the river. We do not believe it is a sensible approach to develop options and plan expensive interventions before there is demonstrable need for the investments. This is why we propose to continue to monitor water quality and take information from the WRMP as to what flows are required from the sources to influence when we trigger the decision to invest
Relative Likelihood	10%. As mentioned above, the predicted AMP in which we expect the raw water to deteriorate sufficiently to require mitigation investment is towards the end of the LTDS period as water quality changes resulting from land uses practices have historically shown a lag effect between when application of fertiliser or farmer practices change and when the water quality change is measured in the river.
Monitoring the alternative pathway	We will continue to monitor nitrate (and other contaminants in the river such as pesticides) concentrations, online in real time and through grab samples, trending them and forecasting plausible future concentrations at average and peak level. We will also monitor the concentrations in our alternative water sources (Queensmead Lake and the TWUL raw water reservoirs) and predict future trends for these data points. Based on these plausible future trends we will estimate when, or if, we are likely to reach a time at which we can no longer manager the nitrate (or other contaminant) concentration in the raw water at the treatment works through blending. At this time we will trigger the high Catchment Care scenario pathway and implement an alternative water quality mitigation approach

6.1 Resilience – Water network resilience to climate change

Table 37: Climate change RCP 8.5 and 2.6 scenarios:

Nature of impact	The rate of Climate change will increase the frequency of bursts within our water network, as more extreme weather drivers faster and more pronounced changes in soil moisture causing ground movement which in turn bursts water mains, particularly those in clay soils and made of more brittle materials such as cast iron.
Method of testing	The impact of the adverse climate change scenario (RCP 8.5) was assessed by an analysis that examined the correlation between historic groundwater level fluctuation and changes on number of bursts. Using this relationship, we applied it to projected groundwater models of our central area, which were derived from the stochastic modelling used in the WRMP. The assessment the benign climate scenario (RCP 2.6) was determined by considering the relationship between benign and adverse emission scenarios analysed by Atkins on the "Regional Water Resources Planning: Climate Data Tools" report. For more detailed information, please refer to Appendix AFW14 of our PR24 business plan.
Extent of impact	As shown in Figure 11, Under the 'slow' RCP 2.6 scenario, the impact is forecast to increase up to 57 bursts by 2050 across our network, whereas RCP8.5 is forecast to increase up to 121 bursts. Our core pathway approach will cover the effects related to RCP 2.6 scenario. There is uncertainty about the occurrence and frequency of severe weather events, as a result our alternative pathway needs to have an adaptive approach informed by ongoing monitoring and be data driven.
Justification & Evidence	These forecasts are the result of analysis of the RCP 8.5 scenario impact on groundwater level changes, and the increasingly strong correlation this has shown with bursts on our network over recent years. For more detail on the underlying analysis, please see Appendix AFW14 to our PR24 business plan.
Decision & Trigger Points	The decision point to deviate from the Core Pathway onto the Adaptive Pathway will be triggered by the climate change impact on our actual burst rate data against our projections. Where it is observed that an excessive increased burst rate related to severe weather conditions is posing a substantial threat to the resilience of the water supply by 2030, we will trigger the development of options to further mitigate, adapting the investments with adjusted climate change projections over each AMP.
Relative Likelihood	10-25%. RCP2.6 is characterised by 1.5 degrees of warming. Currently projections are that this is highly likely to be exceeded due to current levels of global action. RCP 8.5 is just as unlikely as it is a 3.5 - 4 degrees warming future, which would occur through no intervention in climate change. The relative future is likely a median between the two RCP scenarios.
Monitoring the alternative pathway	We will continually monitor Climate Change using the Met Office data, in line with the UKCP18 Guidance, and continually update our models of the impact on the network. We will continue to develop insights regarding our vulnerable climate mains and share this with the wider industry through our open data initiative. Monitoring plan in the strategy will include: - Monitoring of Met Office Data regarding weather events - Monitoring of our Burst rate performance metric - Continued root cause analysis of bursts failure - Frequency at which the performance will be monitored, analysed, and reviewed

Table 38: Slower and faster technology scenarios:

Nature of impact	The plausible extremes of technology scenarios will not materially impact our pathways; however, it will impact the extent to which similar technologies can offset the impact of climate change and associated unit costs of improvements. We have carried out sensitivity analysis to understand the efficiency gain by the technology developments and improvements that will enable cost-effective solutions.
Method of testing	The fast and slow scenarios were tested through internal workshops with external support from PA Consulting. Consideration was given to relevant emerging technologies and likely unit costs were forecast based on those current technologies and efficiencies.
Extent of impact	Our strategy is adaptable, we will deliver network calming activity to mitigate climate change impact, adjusted over each AMP and fed by ongoing monitoring and better quality of data. As a result, neither slower nor faster technology scenarios materially impact the pathway to the point where the adaptive pathways are required.
Justification & Evidence	The requirement, and extent of further enhancement investment is uncertain, dependent upon the climate change scenario. We forecast that within the plausible extremes of fast or slow technology scenarios, sufficient development of relevant technologies will have occurred to enable cost-effective solutions. Based upon current network calming unit costs, an efficiency gain of 23% will enable cost-beneficial solutions in the adverse climate change scenario RCP 8.5 – adaptive pathway. Our research indicates that these advances are likely to be within the 'smart water supply networks' and a fifth industrial revolution. As such, we have reflected these within our Innovation Priorities and have already begun engaging in relevant projects, for example as a partner in the Ofwat Innovation Fund 'Smart Safe Systems' project.
Ongoing monitoring	With one of our ten innovation priorities focused on reducing mains bursts, we will continually focus, monitor and trial technologies that can mitigate the impacts of climate change on our water network, adjusting our delivery plans to make the best use of the technologies available.

Table 39: High and low demand scenarios:

Nature of impact	Growth in demand has the potential to create additional stresses within the water network as flows within existing assets increases, however there is no evidence that this will increase the risk posed directly by climate change on the bursts within our network within the plausible extremes of this scenario. Other investment areas, including WRMP and base costs will be used to manage this risk.
Method of testing	Assessed through judgement of internal and external consultant experts.
Extent of impact	No material impact on the pathway at either plausible extreme.
Justification & Evidence	Given that this investment pathway focuses purely on addressing the impacts of climate change on mains bursts, there is no evidence that population and associated demand growth will materially impact the scale of the climate change impact and therefore the investment pathway. This has been confirmed by our internal engineering teams and external consultancy advice.
Ongoing monitoring	We will monitor population growth and assess any interaction with climate change impact on our water network on each of the 5-yearly planning cycles.

Table 40: High and low abstraction reduction scenarios:

Nature of impact	With increased abstraction reduction, our WRMP and WINEP pathways will increase the proportion of surface water used in our network. Whilst both will be treated to the highest drinking water standards, surface water is more susceptible to temperature variation due to the external climate. We have observed that areas served with surface water suffer from more bursts in colder weather than those in ground water fed areas, therefore, with more extreme winter temperatures through climate change as more of the water we supply is from surface water sources, the more bursts are likely to occur. Over 46% of our climate vulnerable mains are currently supplied by ground water sources (530km) which will reduce to approximately 30% by under the low abstraction reduction pathway, and approximately 21% over the high abstraction reduction pathway by 2050.
Method of testing	Assessment of source water type as a factor in burst rate in our climate vulnerable mains during recent extreme weather events. Should a demonstrable impact have been observed, this relationship would then be used to modify the forecast impact of climate change on burst rates, and the pathway accordingly.
Extent of impact	No material impact on the pathway at either plausible extreme.
Justification & Evidence	Analysis of recent extreme weather events indicates that there is a difference between ground and surface water in the increase of burst rate of our climate vulnerable mains. Climate vulnerable mains with ground water see an increase in bursts of on average around 173%, whereas surface water see a 207% increase. This suggests a potential increase in vulnerability c.20%, which, if applied to all ground water supplied climate vulnerable mains, could see a total increase in bursts of vulnerability to climate change increase by 9% applied to each of the RCVs.
Ongoing monitoring	As we experience more extreme weather events and transition increasingly to surface water, more data will be available to understand this relationship, even more so should greater open data allow access to similar data from other water companies. We will therefore reassess this relationship in line with our 5-year regulatory planning cycle and revisit our pathways accordingly.

6.2 Resilience - Flooding

Table 41: Climate change RCP 8.5 and 2.6 scenarios:

Nature of impact	Climate change will increase the likelihood and severity of flood risks our sites face at plausible extremes. With more extreme weather events, peak flows of water courses and the pace of variation in groundwater are both forecast to increase. This will increase the number of at-risk sites and the degree of protection required at many of these sites. Our core pathway has been created based upon a mid-point of this climate change impact.
Method of testing	We tested our pathway using based upon Environment Agency climate change impact forecasts, which outlines plausible ranges of peak river flows, which can be equated to the flood risk we will face, and associated expenditure required.
Extent of impact	Our core pathway mitigates flood risk at a mid-point between the two plausible extremes. Under RCP8.5, we forecast an additional 12 sites at risk of flooding by 2050, with more extensive protection required across all protected sites. We estimate this additional cost to be a maximum of £2.31m above the core pathway within a single 5-year period, therefore not requiring an adaptive pathway, rather close monitoring in use of modular solutions to build protection in line with risk over the period. Under RCP2.6, we forecast that no additional sites are at risk of flooding by 2050. Our core pathway includes adequate protection at all these sites.
Justification & Evidence	Analysis indicates that a 20% increase in peak river flows due to climate change would, on average, increase the level of flood protection required at flood prone sites by approximately 300 millimetres. We have used this relationship to forecast increased flood risk based upon forecast peak river flows from Environment Agency climate change forecasts.

	Current climate change impact forecasts, published by the Environment Agency, provide forecast increases in peak river flows 60 at each of our catchments at 50th, 70th and 95th percentiles out to 2050 and beyond. Whilst precise correlation to RCP has not been possible, P50 can be broadly equated to marginally above an RCP2.6 scenario, with 95th percentile being marginally above RCP 8.5. Our core pathway ensures resilience to a 70th percentile increase. Our 2025 - 2030 investment period manages flood risk to below the 2050 50th percentile level with later investment increasing protections to the 70th percentile, ensuring investment between 2025 - 2030 remains resilient even in an RCP2.6 scenario. Published peak river flow climate change allowances show the anticipated increases in peak river flows through our key catchments are shown in Table,Table and Table below.
Ongoing monitoring	We will reassess our flood risk across all sites on a 5-yearly basis, informed by the latest flood modelling and climate change forecasting.

Table 42: 70th percentile peak river flow climate change allowances

Management Catchment Name	River Basin District	2020s Higher Central	2050s Higher Central	2080s Higher Central
Cam & Ely Ouse	Anglian	7%	5%	19%
Colne	Thames	16%	16%	35%
Combined Essex	Anglian	13%	16%	38%
London	Thames	14%	14%	27%
Rother	South-East	19%	23%	38%
Upper Lee	Thames	9%	7%	22%

Table 43: 50th percentile peak river flow climate change allowances

Management Catchment Name	River Basin District	2020s Central	2050s Central	2080s Central
Cam & Ely Ouse	Anglian	2%	-2%	9%
Colne	Thames	10%	8%	21%
Combined Essex	Anglian	7%	8%	25%
London	Thames	10%	7%	17%
Rother	South-East	15%	16%	28%
Upper Lee	Thames	3%	-1%	10%

Table 44: 95th percentile peak river flow climate change allowances

Management Catchment Name	River Basin District	2020s Upper End	2050s Upper End	2080s Upper End
Cam & Ely Ouse	Anglian	21%	22%	45%
Colne	Thames	30%	38%	72%
Combined Essex	Anglian	27%	37%	72%
London	Thames	26%	30%	54%
Rother	South-East	29%	38%	66%
Upper Lee	Thames	23%	27%	59%

[60] Peak river flow refers to the maximum rate at which a volume of water passes through a river during a period or event, such as a prolong period of frequency and intense rainfall.

Table 45: Slower and faster technology scenarios:

Nature of impact	The faster technology scenario will likely increase awareness and understanding of forthcoming flood events through advances in modelling and more open data. This may improve the effectiveness of our flood resilience water supply contingency plans but is unlikely to have any material impact on the requirements of our flood resilience programme. In addition, climate and flood modelling advances will continually improve the accuracy of prediction in need, improving the cost-benefit of our investments as we improve our targeting.
Method of testing	We have undertaken a horizon scan of current and emerging technologies that may change the solutions needed in managing our flood risks. The plausible extremes of the pace of their adoption were then considered in line with the common reference scenario.
Extent of impact	We do not forecast either slow or fast technology scenario to materially impact the requirements or cost of delivering the core pathway.
Justification & Evidence	We have assessed recent advances in flood model capabilities, examining how they have improved the accuracy of flood impact prediction and the associated impact on our evaluation of flood risks. Previous advances have driven us to marginally increase expenditure in flood mitigation as we better understand flood risk for each site. To identify any likely material changes in investment levels we have used expert assessment to forecast how these are likely to advance further over the next 25-years.
Ongoing monitoring	We will monitor technological developments through our delivery partners and in consultation with flood authorities, using the latest modelling and best value flood mitigation approaches available to inform investments at each 5-year investment planning cycle.

Table46: High and low demand scenarios:

Nature of impact	We anticipate that the high demand scenario induced by population growth, will place a greater criticality on the assets we use to supply water to our customers, resulting in increased investment in flood resilience to protect all sites of a given criticality.
Method of testing	Assessment of likely population growth within each hydraulic demand zone, to determine changes in criticality of key sites that may increase investment requirements in flood mitigation.
Extent of impact	In a high demand scenario, our adaptive pathway would need to plan to improve flood resilience at a greater number of sites. The cost impact of a high demand scenario is expected to be £2,060k over 25-years to manage increases in flood risks of 11 additional sites. Table 92 below illustrates the projected costs over a 25-year period, for both high and low demand scenarios. We anticipate a comparable increase in population for both high and low growth scenarios, indicating a commensurate upsurge in demand.
Justification & Evidence	As outlined by our WRMP forecasts, we anticipate a 15.10% population increase within our operational region by 2050, accounting for both high and low population growth scenarios. Notably, our data indicates a slight variation of approximately 200,000 in population across our entire company. Please see Table below. Using hydraulic analysis, we have calculated that these concurrent increases in demand will proportionally elevate the criticality of our water supply infrastructure. This effect is poised to result the need for flood resilience measures for an additional 11 sites.
Ongoing monitoring	We will continue to monitor population growth and projected demands through our WRMP and assess their impact on our sites at 5-year investment cycle intervals. By regularly updating and rigorously evaluating risks, we will refine our adaptive strategy to stay effective and to adaptable.

Table 47: 25-year Cost forecast for high and low demand scenarios

Period	High Scenario Population Growth Percentage Increase	Expected Additional Sites Impacted by Flooding (High Scenario)	High Scenario Estimated Cost Impact	Low Scenario Population Growth Percentage Increase	Expected Additional Sites Impacted by Flooding (Low Scenario)	Low Scenario Estimated Cost Impact
2025 – 2030	4.17%	3	£ 500k	4.11%	3	£ 500k
2030 – 2035	3.24%	2	£ 390k	3.24%	2	£ 390k
2035 – 2040	2.57%	2	£ 390k	2.61%	2	£ 390k

2040 – 2045	3.01%	2	£ 390k	3.04%	2	£ 390k
2045 – 2050	3.10%	2	£ 390k	3.12%	2	£ 390k
25-Year Total		11	£ 2,060k		11	£ 2,060k

Table 48: High and low abstraction reduction scenarios

Nature of impact	Reduced abstraction from groundwater can materially change the flood risk in the vicinity because of increased ground saturation. In addition, as we reduce groundwater abstraction, the criticality of other sites is increased as our customers' supplies become more dependent upon these sites. This impact relates chiefly to groundwater risks, a small proportion of the overall expenditure. Our 2025 - 2030 investments include investments only at sites which will not be closed due to abstraction reductions over the 25-year period.
Method of testing	Site flood risk assessments overlaid with our abstraction reduction pathways, which detail changes in site criticality.
Extent of impact	Costs associated with mitigating additional flood risks are included within the schemes where we are planning for abstraction reductions, and therefore do not result in additional costs within the flood resilience pathway at either plausible extreme.
Justification and evidence	Durin the period between 2015 - 2020, in agreement with the Environment Agency, we ceased abstraction from our Fulling Mill source in as part of our sustainability reductions programme. Following this, the Environment Agency (EA) identified an increased risk of flooding of the nearby properties built on the floodplain in the vicinity, as well as elevated flood risk to other downstream properties within Welwyn village. Under the request of the Environment Agency, to manage this risk we have recommissioned our site. Since this incident we have sought to better understand the link between abstraction reductions and flood risks and include appropriate assessments and mitigations within our planning of such schemes.
Ongoing monitoring	To continually assess the impact of this scenario through the LTDS period, we will monitor sustainability reductions and water resources through our WRMP, as well as continually monitoring local borehole and river levels to assess the materiality of this scenario going forward.

6.3 Resilience - Single Points of Failure

Table 49: Climate change RCP 8.5 and 2.6 scenarios:

Nature of impact	As part of our SPOF scenario testing, it was considered that some of the impacts of climate change to our business, like increasing demand due to higher temperature or reduced supply of raw water due to drought, may exacerbate the prevalence or risk of SPOFs and necessitate more investment. However, for the SPOFs core pathway, these impacts were not material enough to consider the development of an alternative pathway.
Method of testing	Criticality analysis, Asset Risk Register combined with climate change scenario testing
Extent of impact	There is no material effect on the core pathway approach related to the RCP 8.5 or 2.6 scenarios, as the programme is designed to deliver all SPOF mitigation within the climate change scenarios and this ambition does not change with climate change forecasts.
Justification & Evidence	Climate change will affect burst rates differently by 2050, with 121.15 bursts per year in the 8.5 scenario and 57.01 bursts per year in the 2.6 scenario (see Figure 11). However, the need and scope of the SPOF program will stay the same for both scenarios. The investment pace may vary, but we can manage it through our monitoring strategy.
Ongoing monitoring	We will monitor climate change using Met Office data per UKCP18 Guidance. If significant changes occur, we'll analyse whether increased or re-sequenced investment is needed to address climate change effects.

Table 50: Slower and faster technology scenarios:

Nature of impact	Technological advancements may introduce new repair and restoration techniques, as well as early warning systems. These could potentially alter SPOF program costs and sequencing, but their quantifiable impact remains uncertain
Method of testing	Analysis of technology improvements within asset classes targeted by the investment programme.
Extent of impact	In the Fast Technology scenario, smart asset monitoring by 2035 reduces non-infra-asset and water network ancillary spending. This effect is less pronounced for water mains. SPOF expenditure might decrease by £12m but doesn't warrant an adaptive pathway (cost estimate from 2035 - 2050). In the Slow Technology scenario, smart monitoring by 2040 lowers non-infra-asset and ancillary spending, with a reduced impact on water mains due to challenging corrosion monitoring. SPOF expenditure may rise by up to £2m per year, still not necessitating an adaptive pathway (cost estimate includes additional 40 FTE for outage mitigation). In the Fast technology scenario, expenditure on SPOFs may need to increase by up to £2m per annum, however this is insufficiently material to require an adaptive pathway (cost estimated based on the additional 40FTE to mitigate electricity and digital outages).
Justification & Evidence	In the Fast Technology scenario, there is a possibility of eliminating the necessity to address failures in non-infra-assets. This potential stems from enhanced reliability, more precise failure prediction, and improved capabilities for swift recovery and service restoration in case of failures. However, in the context of buried infrastructure assets, the accelerated technology scenario might not be sufficient to detect localised failures caused by factors like localised corrosion or weaknesses stemming from historical conditions (such as historical transients or weaknesses from the time of installation).
Ongoing monitoring	Technology advancement will be monitored and driven through data sharing and active involvement in innovations cross-sector and across the industry via club projects (UKWIR or WRC projects) and use of OFWAT innovation fund. We will monitor particularly progress on Trunk main asset condition data and failure root cause analysis using AI.

Table 51: High and low demand scenarios:

Nature of impact	Testing demand scenarios against the SPOFs core pathway revealed that increased demand might affect the number of SPOFs. Greater network demand could strain mains capacity, lower pressure, and raise storage requirements, potentially increasing the likelihood or impact of failures.
Method of testing	We assessed the benign and adverse scenarios in an internal workshop led by relevant SMEs
Extent of impact	According to our WRMP forecast, the population in the Affinity Water supply area will grow from 3,923,690 in 2021/22 to 4,957,510 by 2049/2050, a 26.35% increase of 1,033,820 people. Our SPOFS control measure aims to keep new SPOFs within 20% of the population growth or 5.27% of the current 124 SPOFs. With this growth, we expect 7 additional SPOFs by 2050. In the low demand scenario, population growth is 21.07% lower than in our WRMP forecast. Despite SPOF prevention measures, there may be a 1.06% increase in new SPOFs, potentially resulting in 2 additional SPOFs (excluding infrastructure charge-funded ones). This scenario could reduce the pathway by up to £4.92m by 2050, which is below the materiality threshold for an alternative pathway In the high demand scenario, population growth exceeds the WRMP forecast by 4.65%. Despite SPOF prevention measures, there may be a 6.2% increase in new SPOFs, potentially resulting in 8 additional SPOFs (excluding infrastructure charge-funded ones). This scenario could raise the pathway by up to £0.98m by 2050, below the materiality threshold for an alternative pathway
Justification & Evidence	The core pathway remains unchanged regardless of high or low demand scenarios, as it aims to mitigate all SPOFs within these scenarios. Available demand forecasts do not alter this ambition. Any potential increase in risk due to increased demand can be addressed through our SPOFs core pathway investment, monitored by tracking SPOF numbers and risk indexes.
Ongoing monitoring	Population growth will be continuously monitored and accounted for within our SPOF investments as part of our 5-year investment planning cycle.

Table 52: High and low abstraction reduction scenarios:

Nature of impact	While testing the SPOFs core pathway against the abstraction reduction scenarios, it was noted that a reduction in abstraction may cause additional SPOFs due to reductions in availability of ground water and need for changing abstraction and network solutions.
Method of testing	Assessment of our internal investment planning procedures and associated regulatory guidance
Extent of impact	This impact was deemed immaterial to our SPOFs core pathway. We prioritize resilience before abstraction reduction and reinforce the network to prevent new SPOFs. Additional spending on an SPOFs program would duplicate investment and not benefit customers.
Justification & Evidence	The core pathway remains unaffected by high or low abstraction reduction scenarios. It's designed to mitigate all SPOFs within these scenarios, and this ambition remains unchanged by abstraction reduction forecasts.
Ongoing monitoring	Our bi-annual refresh of the critical link analysis will ensure no abstraction reduction activity creates additional SPOFs in the way it is delivered.

7.1 SEMD - cyber security

Table 53: Climate change RCP 8.5 and 2.6 scenarios:

Nature of impact	Climate change is anticipated to have limited impact on the core pathway for cyber security and can be managed through existing business continuity plans that consider the impact of increased inflation and will not require an alternative pathway.
Method of testing	Expert judgement and analysing using historic data.
Extent of impact	Climate change can increase the frequency and intensity of extreme weather events and these events can disrupt critical infrastructure, damaged IT data centres, and disrupt communication networks, leading to potential cyber vulnerabilities and extended downtime. Therefore, climate change may marginally increase the cost of resources including energy, people, and technology, but this can be managed through existing business continuity plans that consider the impact of increased inflation and will not require an alternative pathway.
Justification & Evidence	The cyber threat and risk level are currently very high. Climate change will have little impact on increasing the overall cyber risk level faced by the business in delivering the essential services. there have been a series of public statements from Lindy Cameron, CEO National Cyber Security Centre and other authorities on cyber risk management regarding the increased threat to UK Critical National Infrastructure (CNI) from state aligned cyber actors.
Ongoing monitoring	The current controls are reviewed annually with DWI, with new targets set for each AMP. New requirements will be managed accordingly and will not require an alternative pathway.

Table 54: Faster & slower technology scenarios:

Nature of impact	In the faster scenario, reliance on technology increases, which causes progressively higher risks of failure, and increasing threats from cyber-attacks throughout the period to 2050. The likely outcomes of this scenario are: • A cloud-first strategy. • An increase in internet-enabled systems in OT. • Convergence of IT and OT systems. • Increasing use of the Internet of Things (IoT). • Widescale vulnerability in major IT elements forcing wholesale replacement. In the slower scenario, cyber security and digital protection advance more quickly than the sophistication of cybercrime. Digital networks will remain resilient through 2050.

	This scenario's likely outcomes are like those within the faster technology scenario.
Method of testing	Actual result of Affinity Water digital transformation and that of other businesses. Cloud use is increasing and provides significant benefits for businesses of all sizes and industry. This is the reason why the UK government introduced a 'Cloud First' policy in 2013 for all technology decisions.
Extent of impact	We have seen faster technological changes both within the company and generally, with software companies struggling to keep up with the cyber risks. In December 2020 Software company's network monitoring product that had access to many IT systems was compromised and allowed the hackers to access the data and networks of thousands of organisations globally, including multiple government departments and the private sector.
Justification & Evidence	Affinity Water has been on a digital transformation over the last six years, leading the water sector in IT public cloud use. Covid-19 has accelerated digital transformation activities, with many users requiring new working methods, including immediate remote work.
Ongoing monitoring	We will monitor technology development and advance in cyber security threats over the next AMP. We expect to see more IT and OT assets being exposed to the internet and managed remotely and a significant increase in Artificial Intelligence challenges and opportunities for businesses.

Table 55: Higher and lower demand scenarios:

Nature of impact	We anticipate that the high demand scenario induced by population growth will increase people and technology required to support the increased demand, resulting in increased investment in cyber resilience of our critical sites and essential services.
Method of testing	Assessment of likely population growth within each hydraulic demand zone, to determine changes in criticality of key sites that may increase investment requirements in cyber risk mitigation.
Extent of impact	In a high demand scenario, the cost to secure and support the essential services will increase, but this can be managed through existing business plans that consider the impact of demand linked cost and will not require an alternative pathway.
Justification & Evidence	Changes in customer numbers taken from our IT databases and occupancy forecasts taken from local councils and unitary authority plans and ONS population and household projections.
Ongoing monitoring	We will monitor demands using our IT systems for both customer demand and for the changes to people and technology to support this increase.

Table 56: Higher and lower abstraction reduction scenarios:

Nature of impact	Abstraction reduction is not anticipated to cause significant changes to the way we manage cyber risks within the high and low abstraction reduction scenarios across the 25 years. Abstraction reduction may increase sites designated as critical infrastructure sites. This change may increase the cost to protect these sites, but each AMP can be monitored, and slight adjustments to people, technology, and processes to support this change can be made.
Method of testing	Feedback from other business areas that closely monitor lower and higher abstraction reductions and annual cybersecurity reports from trusted sources such as the National Cyber Security Centre (NCSC), as well as closely examining regulatory changes that could impact cyber security controls.
Extent of impact	Contingency budgets are included within the core pathway to support new cyber security challenges, and therefore do not result in additional costs within each AMP.
Justification & Evidence	The experience gained in monitoring technology investments at Affinity Water during the last five years, including obtaining three quotes for shortlisting similar products as those for the core pathway.
Ongoing monitoring	To continually assess the impact of this scenario through the LTDS period, we will monitor sustainability reductions and water resources through our WRMP, as well as continually monitoring local borehole and river levels to assess the materiality of this scenario going forward.

7.2 SEMD - physical

Table 57: Climate change RCP 8.5 and 2.6 scenarios:

Nature of impact	Both Egham and Sunnymeads are situated proximal to the river Thames and are therefore potentially susceptible to fluvial flooding, although AW have significantly invested over the last 4 AMPs in resilience against flooding.
Method of testing	AW work closely with the Environment Agency and Local Resilience Forums regarding flood impacts along the Thames.
Extent of impact	The extent of impact has been in part mitigated by investment in flood protection over previous AMPs. The mitigation has taken the form of installing equipment off the ground, installing flood doors, and building flood protection for 1:100 years + 30cm freeboard, buying 4x4 flood vehicles, water safety training, high volume pumps and flood barriers. However, a loss of site could potentially impact a large number of customers through the loss of site. Therefore, additional resilience has been planned for through a ring main which can move water across multiple surface water sites, (Egham, Chertsey, Walton and Iver).
Justification & Evidence	Under the 8.5 scenario, weather events such as flooding are expected to become more frequent and extreme. Although many of the doors have already been upgraded to withstand 1:100-year flood event plus 30cm freeboard level of resilience, this might need to be upgraded in the future to maintain this. This is, however, uncertain and not materially quantifiable to necessitate any change in our core pathway. It should also be noted that all enhancement work is due to be completed by 2030 when the adverse scenario will be less prominent.
Ongoing monitoring	If the cutting and drilling technology increases with battery powered tools, then it is expected that the Water UK Security Standards (WUKSS 2022) will reflect these changes. Any new installation by AW will adhere to these changes.

Table 58: Slower and faster technology scenarios:

Nature of impact	The security measures installed are scoped through an Operational Requirements assessment and are installed according to the Water UK Security Standards.
Method of testing	An annual internal audit of each of the CNI sites is conducted and reported to the DWI. Once each AMP, an external audit is carried out to ensure that AW are compliant with the SEMD.
Extent of impact	The extent of the impact is mitigated in part by the quality of protective security installed. The assets are protected by Sr4 (D10) rated security products.
Justification & Evidence	There is a low and unlikely threat from cyber-attacks on remote security systems as OT is currently isolated from IT systems. There is therefore very little impact on the core pathway approach related to the slower technology scenario that can be quantified. It should also be noted that all enhancement work is due to be completed by 2030 when the adverse scenario will be less prominent.
Ongoing monitoring	This will be monitored through annual SEMD audits and reflected within 5 yearly investment cycles.

Table 59: High and low demand scenarios:

Nature of impact	Higher demand could potentially impact upon the site security classification (based in part upon the population the site serves).
Method of testing	An operational requirement and security risk assessment would be carried out on a bespoke site basis if the population change affects the security classification.
Extent of impact	The core pathway is impacted by the benign and adverse scenarios and If the population grows and the output of the sites increases, then potentially the site may require a site upgrade. Dependent on the extent of changes required the work may be included in our future business plans or if applicable addressed through base investment.
Justification & Evidence	The output from the security risk assessment would determine any change and provide the justification.
Ongoing monitoring	This will be monitored through annual SEMD audits and reflected within 5 yearly investment cycles.

Table 60: High and low abstraction reduction scenarios:

Nature of impact	The site security classification is mainly based on the population served, however, if unknown, there is a provision to base the site security classification on the site output (which related to lower / higher abstraction). AW can accurately identify the population served for each production asset by network modelling and use this methodology to calculate the site security classification.
Method of testing	AW review the population served by each of their assets, through network modelling. This review was last carried out in 2023.
Extent of impact	A change to a lower abstraction figure has a negligible impact upon security as the physical security measures will already be in place on the current sites. New sites will be assessed whilst they are in the design phase, and the relevant security classification implemented.
Justification & Evidence	Recent evidence of this process was at the AW Sundon Reservoir site which was taken over from Anglian Water. The site output has been increased with the addition of an extra reservoir cell. This changed the site security classification from a Cat 1 high to a Cat 2 low. The security requirements were part of the design work and new hatches, hatch protection and alarm verification have been installed.
Ongoing monitoring	Abstraction is linked to site licences monitored by the EA. Increased abstraction and therefore outputs are unlikely to affect CNI assets, with the exception of a pollution incident in the river Thames. AW have a backup emergency lake source for such issues and any pollution is likely to be moved along by the flow of the river. A scenario where the river becomes so low that the AW surface water sites can no longer draw water would be recognised through river monitoring by the Environment Agency.

7.3 SEMD emergency planning

Table 61: Climate change RCP 8.5 and 2.6 scenarios:

Nature of impact	If unmitigated, climate change driven extreme weather events will increase the frequency of use our emergency response capabilities, including our tankering fleet. This will be caused through higher asset failure, most significantly through mains bursts or flooding risk. However, given our LTDS pathways to mitigate these effects, these are not anticipated to materially impact this core pathway.
Method of testing	Analysis of asset failure risk and climate change adaption reports, with comparison to our LTDS Resilient Assets & Systems investment strategies.
Extent of impact	No material impact is forecast, provided resilient assets & systems and invested in accordingly.
Justification & Evidence	As per Resilient Assets & Systems investment strategies.
Ongoing monitoring	We will continually monitor the frequency of events requiring emergency response capability on an annual basis and reflect any increasing risk level caused by climate change within our 5-yearly business planning process.

Table 62: Slower and faster technology scenarios:

Nature of impact	Pace of technology development will impact our SEMD emergency planning investments in two ways, through smart water supply networks reducing the frequency of emergency response capability being used and in the timing of transition to low emission tankers as part of wider HGV transition. Under the Fast technology scenario, smart water supply network will be realised by 2035 and low emissions by 2030. Under the Slow scenario this will be 2040 for both.
Method of testing	Sensitivity testing of our optioneering economic assessments to reduced utilisation of emergency response capability from both 2035 and 2040, and of renewal of existing tankering fleet to low emission alternatives by 2030 and 2040.
Extent of impact	Under the fast technology scenario, the core pathway NPV is marginally impacted as the transition to biodiesel increased costs, partially offset by the reduced net emissions. However, this remains a higher NPV vs increased bottled water capacity alternatives. Under the slow technology scenario core pathway NPVs remain unchanged, as our pathway was designed with this pace of technology adoption as a minimum i.e. transition to low emission fleet by 2040.
Justification & Evidence	It is noted that the timing of when green tankering could be on the market is impacted by the pace of the technology scenario. However, this will not impact the core pathway.
Ongoing monitoring	We will continually monitor the availability of low emission tankers on the market and respond accordingly with best value driven business cases to transition to these within our 5-year investment cycles. We will continually monitor the frequency of events requiring emergency response capability on an annual basis and reflect any decreasing risk level caused by our adoption of smart water supply networks within our SEMD related business cases, ensuing we remain compliant with our explicit obligations.

Table 63: High and low demand scenarios:

Nature of impact	SEMD Emergency Planning requirements are driven by proportionate provision for emergency response capability. Therefore, as population increases between the high and low demand plausible extremes (16% to 21% population increase from 2025-50), the scale of our SEMD Emergency Response investment need also increase.
Method of testing	Use of population forecasts to test the resilience of the core pathway to meeting SEMD requirements and sensitivity testing of economic assessments.
Extent of impact	Our core pathway is designed to meet the SEMD required provision of the low demand scenario. Additional requirements to meet the high demand scenario include further provision, with costs below the materiality threshold requiring alternative pathways.
Justification & Evidence	The range of the plausible extremes of population is at is widest at the end of the period in 2050. At this point, population at High demand is 200,000 above the Low. The additional provision at this point would cost a further £0.2m over a 5-year period.
Ongoing monitoring	Population will be monitored annually. Each 5-year investment period, current and latest forecasts of populations will be accounted for within our SEMD Emergency Planning business cases.

Table 64: High and low abstraction reduction scenarios:

Nature of impact	Abstraction reduction scenarios will not impact upon our SEMD emergency planning core pathway, with our other LTDS investment strategies maintaining the resilience of our water supply across the plausible extremes.
Method of testing	Expert judgement informed by our investment strategies.
Extent of impact	No forecast impact.
Justification & Evidence	As per WRMP and WINEP WFD investment strategies.
Ongoing monitoring	We will annually monitor whether implementation of our abstraction reductions impacts the frequency or severity of incidents requiring emergency response, and therefore potentially impacting the best value pathway for our customers. We will respond to any impact through 5-yearly business planning process.